Fastener Tightening Specifications (L76)

Application	Specification	
	Metric	English
Active Fuel Management Oil Pressure Relief Valve	27 N·m	20 lb ft
Camshaft Position (CMP) Sensor Bolt	12 N·m	106 lb in
CMP Sensor Wire Harness Bolt	12 N·m	106 lb in
Camshaft Retainer Bolts - TORX® Head Bolts	15 N·m	11 lb ft
Camshaft Sprocket Bolt - First Pass	75 N·m	55 lb ft
Camshaft Sprocket Bolt - Final Pass	50 degrees	
Connecting Rod Bolts - First Pass	20 N·m	15 lb ft
Connecting Rod Bolts - Final Pass	85 degrees	
Coolant Air Bleed Pipe and Cover Bolts	12 N·m	106 lb in
Coolant Temperature Sensor	20 N·m	15 lb ft
Crankshaft Balancer Bolt - First Pass	150 N·m	110 lb ft
Crankshaft Balancer Bolt - Second Pass	Loosen 360 degrees	
Crankshaft Balancer Bolt - Third Pass	50 N·m	37 lb ft
Crankshaft Balancer Bolt - Final Pass	230 degrees	
Crankshaft Bearing Cap M8 Bolts	25 N·m	18 lb ft
Crankshaft Bearing Cap M10 Bolts - First Pass in Sequence	20 N·m	15 lb ft
Crankshaft Bearing Cap M10 Bolts - Final Pass in Sequence	80 degrees	
Crankshaft Bearing Cap M10 Studs - First Pass in Sequence	20 N·m	15 lb ft
Crankshaft Bearing Cap M10 Studs - Final Pass in Sequence	51 degrees	
Crankshaft Oil Deflector Nuts	25 N·m	18 lb ft
Crankshaft Position (CKP) Sensor Bolt	25 N·m	18 lb ft
Crankshaft Rear Oil Seal Housing Bolts	30 N·m	22 lb ft
Cylinder Head Coolant Plug	20 N·m	15 lb ft
Cylinder Head M8 Bolts - in Sequence	30 N·m	22 lb ft
Cylinder Head M11 Bolts - First Pass in Sequence	30 N·m	22 lb ft
Cylinder Head M11 Bolts - Second Pass in Sequence	90 degrees	
Cylinder Head M11 Bolts - Final Pass in Sequence	70 degrees	
Engine Block Coolant Drain Hole Plug	60 N·m	44 lb ft
Engine Block Coolant Heater	50 N·m	37 lb ft
Engine Block Oil Gallery Plug	60 N·m	44 lb ft
Evaporative Emission (EVAP) Canister Purge Solenoid Valve Bolt	50 N·m	37 lb ft
Exhaust Manifold Bolts - First Pass	15 N·m	11 lb ft
Exhaust Manifold Bolts - Final Pass	20 N·m	15 lb ft
Exhaust Manifold Heat Shield Bolts	9 N·m	80 lb in
Exhaust Manifold Studs	20 N·m	15 lb ft

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Flex Plate Bolts - First Pass	20 N·m	15 lb ft
Flex Plate Bolts - Second Pass	50 N·m	37 lb ft
Flex Plate Bolts - Final Pass	100 N·m	74 lb ft
Front Cover Bolt	25 N·m	18 lb ft
Fuel Injection Fuel Rail Bolts	10 N·m	89 lb in
Ignition Coil Bracket-to-Valve Rocker Arm Cover Studs	12 N·m	106 lb in
Ignition Coil-to-Bracket Bolts	10 N·m	89 lb in
Intake Manifold Bolts - First Pass in Sequence	5 N·m	44 lb in
Intake Manifold Bolts - Final Pass in Sequence	10 N·m	89 lb in
J 41798 M8 Bolt	25 N·m	18 lb ft
J 41798 M10 Bolts	50 N·m	37 lb ft
Knock Sensor Bolts	20 N·m	15 lb ft
Oil Filter	30 N·m	22 lb ft
Oil Filter Fitting	55 N·m	40 lb ft
Oil Level Indicator Tube Bolt	25 N·m	18 lb ft
Oil Level Sensor	20 N·m	15 lb ft
Oil Pan Baffle Bolt	12 N·m	106 lb in
Oil Pan Closeout Cover Bolt - Left Side	9 N·m	80 lb in
Oil Pan Closeout Cover Bolt - Right Side	9 N·m	80 lb in
Oil Pan Cover Bolts	12 N·m	106 lb in
Oil Pan Drain Plug	25 N·m	18 lb ft
Oil Pan M6 Bolts - Oil Pan-to-Rear Oil Seal Housing	12 N·m	106 lb in
Oil Pan M8 Bolts - Oil Pan-to-Engine Block and Oil Pan-to-Front Cover	25 N·m	18 lb ft
Oil Pressure Sensor	35 N·m	26 lb ft
Oil Pump Cover Bolts	12 N·m	106 lb in
Oil Pump Relief Valve Plug	12 N·m	106 lb in
Oil Pump Screen-to-Oil Pump Bolt	12 N·m	106 lb in
Oil Pump-to-Engine Block Bolts	25 N·m	18 lb ft
Spark Plugs	15 N·m	11 lb ft
Throttle Body Bolts	10 N·m	89 lb in
Timing Chain Tensioner Bolts	25 N·m	18 lb ft
Valve Lifter Oil Manifold Bolts	25 N·m	18 lb ft
Valve Lifter Guide Bolts	10 N·m	89 lb in
Valve Rocker Arm Bolts	30 N·m	22 lb ft
Valve Rocker Arm Cover Bolts	12 N·m	106 lb in
Water Inlet Housing Bolts	15 N·m	11 lb ft
Water Pump Bolts - First Pass	15 N·m	11 lb ft
Water Pump Bolts - Final Pass	30 N·m	22 lb ft

Fastener Tightening Specifications (6.2L LS3)

Application	Specification	
	Metric	English
Active Fuel Management Oil Pressure Relief Valve	27 N·m	20 lb ft
Camshaft Position (CMP) Sensor Bolt	12 N·m	106 lb in
CMP Sensor Wire Harness Bolt	12 N·m	106 lb in
Camshaft Retainer Bolts - Hex Head Bolts	25 N·m	18 lb ft
Camshaft Retainer Bolts - TORX® Head Bolts	15 N·m	11 lb ft
Camshaft Sprocket Bolt - First Pass	75 N·m	55 lb ft
Camshaft Sprocket Bolt - Final Pass	50 degrees	
Clutch Pressure Plate Bolts	70 N·m	52 lb ft
Connecting Rod Bolts - First Pass	20 N·m	15 lb ft
Connecting Rod Bolts - Final Pass	85 degrees	
Coolant Air Bleed Pipe and Cover Bolts	12 N·m	106 lb in
Coolant Temperature Sensor	20 N·m	15 lb ft
Crankshaft Balancer Bolt - First Pass	150 N·m	111 lb ft
Crankshaft Balancer Bolt - Second Pass	Loosen 360 degrees	
Crankshaft Balancer Bolt - Third Pass	50 N·m	37 lb ft
Crankshaft Balancer Bolt - Final Pass	230 degrees	
Crankshaft Bearing Cap M10 Bolts - First Pass in Sequence	20 N·m	15 lb ft
Crankshaft Bearing Cap M10 Bolts - Final Pass in Sequence	80 degrees	
Crankshaft Bearing Cap M10 Studs - First Pass in Sequence	20 N·m	15 lb ft
Crankshaft Bearing Cap M10 Studs - Final Pass in Sequence	51 degrees	
Crankshaft Bearing Cap M8 Bolts	25 N·m	18 lb ft
Crankshaft Oil Deflector Nuts	25 N·m	18 lb ft
Crankshaft Position (CKP) Sensor Bolt	25 N·m	18 lb ft
Crankshaft Rear Oil Seal Housing Bolts	30 N·m	22 lb ft
Cylinder Head M11 Bolts - First Pass in Sequence	30 N·m	22 lb ft
Cylinder Head M11 Bolts - Second Pass in Sequence	90 degrees	
Cylinder Head M11 Bolts - Final Pass in Sequence	70 degrees	
Cylinder Head M8 Bolts - in Sequence	30 N·m	22 lb ft
Cylinder Head Coolant Plug	20 N·m	15 lb ft
Engine Block Coolant Drain Hole Plug	60 N·m	44 lb ft
Engine Block Coolant Heater	50 N·m	37 lb ft
Engine Block Oil Gallery Plug	60 N·m	44 lb ft
Evaporative Emission (EVAP) Canister Purge Solenoid Valve Bolt	50 N·m	37 lb ft
Exhaust Manifold Bolts - First Pass	15 N·m	11 lb ft
Exhaust Manifold Bolts - Final Pass	20 N·m	15 lb ft

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Exhaust Manifold Heat Shield Bolts	9 N·m	80 lb in
Exhaust Manifold Stud	20 N·m	15 lb ft
Flywheel Bolts - First Pass	20 N·m	15 lb ft
Flywheel Bolts - Second Pass	50 N·m	37 lb ft
Flywheel Bolts - Final Pass	100 N·m	74 lb ft
Front Cover Bolts	25 N·m	18 lb ft
Fuel Injection Fuel Rail Bolts	10 N·m	89 lb in
Ignition Coil Bracket-to-Valve Rocker Arm Cover Stud	12 N·m	106 lb in
Ignition Coil-to-Bracket Bolts	10 N·m	89 lb in
Intake Manifold Bolts - First Pass in Sequence	5 N·m	44 lb in
Intake Manifold Bolts - Final Pass in Sequence	10 N·m	89 lb in
J 41798 M8 Bolt	25 N·m	18 lb ft
J 41798 M10 Bolts	50 N·m	37 lb ft
Knock Sensor Bolts	20 N·m	15 lb ft
Motor Mount Bracket Bolts	50 N·m	37 lb ft
Oil Filter	30 N·m	22 lb ft
Oil Filter Fitting	55 N·m	40 lb ft
Oil Level Indicator Tube Bolt	25 N·m	18 lb ft
Oil Level Sensor	13 N·m	115 lb in
Oil Pan Closeout Cover Bolt - Left Side	9 N·m	80 lb in
Oil Pan Closeout Cover Bolt - Right Side	9 N·m	80 lb in
Oil Pan Cover Bolts	12 N·m	106 lb in
Oil Pan Drain Plug	25 N·m	18 lb ft
Oil Pan M6 Bolts - Oil Pan-to-Rear Oil Seal Housing	12 N·m	106 lb in
Oil Pan M8 Bolts - Oil Pan-to-Engine Block and Oil Pan-to-Front Cover	25 N·m	18 lb ft
Oil Pressure Sensor	35 N·m	26 lb ft
Oil Pump Cover Bolts	12 N·m	106 lb in
Oil Pump Relief Valve Plug	12 N·m	106 lb in
Oil Pump Screen Nuts	25 N·m	18 lb ft
Oil Pump Screen-to-Oil Pump Bolt	12 N·m	106 lb in
Oil Pump-to-Engine Block Bolts	25 N·m	18 lb ft
Spark Plugs	15 N·m	11 lb ft
Throttle Body Bolts	10 N·m	89 lb in
Timing Chain Tensioner Bolts	25 N·m	18 lb ft
Valley Cover Bolts	25 N·m	18 lb ft
Valve Lifter Guide Bolts	12 N·m	106 lb in
Valve Rocker Arm Bolts	30 N·m	22 lb ft
Valve Rocker Arm Cover Bolts	12 N·m	106 lb in
Water Inlet Housing Bolts	15 N·m	11 lb ft
Water Pump Bolts - First Pass	15 N·m	11 lb ft

Water Pump Bolts - Final Pass	30 N·m	22 lb ft

Engine Mechanical Specifications (L76)

Application	Specification	
	Metric	English
Engine Type	V8	
Displacement	5697 cu cm	348 cu in
RPO	L76	
Bore	101.618-101.636 mm	4.0007-4.0017 in
Stroke	92.0 mm	3.622 in
Compression Ratio	9.67:1	
Firing Order	1-8-7-2-6-5-4-3	
Active Fuel Management Cylinders	1-4-6-7	
Spark Plug Gap	1.02 mm	0.04 in
Block		
Camshaft Bearing Bore 1 and 5 Diameter	59.58-59.63 mm	2.345-2.347 in
Camshaft Bearing Bore 2 and 4 Diameter	59.08-59.13 mm	2.325-2.327 in
Camshaft Bearing Bore 3 Diameter	58.58-58.63 mm	2.306-2.308 in
Crankshaft Main Bearing Bore Diameter	69.871-69.889 mm	2.75-2.751 in
Crankshaft Main Bearing Bore Out-of-Round	0.006 mm	0.0002 in
Cylinder Bore Diameter	101.618-101.636 mm	4.0007-4.0017 in
Cylinder Head Deck Height - Measuring from the Centerline of Crankshaft to the Deck Face	234.57-234.82 mm	9.235-9.245 in
Cylinder Head Deck Surface Flatness - Measured Within a 152.4 mm (6.0 in) Area	0.11 mm	0.004 in
Cylinder Head Deck Surface Flatness - Measuring the Overall Length of the Block Deck	0.22 mm	0.008 in
Valve Lifter Bore Diameter	21.417-21.443 mm	0.843-0.844 in
Camshaft		
Camshaft End Play	0.025-0.305 mm	0.001-0.012 in
Camshaft Journal Diameter	54.99-55.04 mm	2.164-2.166 in
Camshaft Journal Out-of-Round	0.025 mm	0.001 in
Camshaft Lobe Lift - Exhaust - Non Active Fuel Management Cylinders	7.17 mm	0.282 in
Camshaft Lobe Lift - Exhaust - Active Fuel Management Cylinders	7.3 mm	0.287 in

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Camshaft Lobe Lift - Intake - Non Active Fuel Management Cylinders	7.08 mm	0.279 in
Camshaft Lobe Lift - Intake - Active Fuel Management Cylinders	7.2 mm	0.283 in
Camshaft Runout - Measured at the Intermediate Journals	0.05 mm	0.002 in
Connecting Rod		
Connecting Rod Bearing Clearance - Production	0.023-0.065 mm	0.0009-0.0025 in
Connecting Rod Bearing Clearance - Service	0.023-0.076 mm	0.0009-0.003 in
Connecting Rod Bore Diameter - Bearing End	56.505-56.525 mm	2.224-2.225 in
Connecting Rod Bore Out-of-Round - Bearing End - Production	0.004-0.008 mm	0.00015-0.0003 in
Connecting Rod Bore Out-of-Round - Bearing End - Service	0.004-0.008 mm	0.00015-0.0003 in
Connecting Rod Side Clearance	0.11-0.51 mm	0.00433-0.02 in
Crankshaft		
Connecting Rod Journal Diameter - Production	53.318 mm 53.338 mm	2.0991 in 2.0999 in
Connecting Rod Journal Diameter - Service	53.308 mm	2.0987 in
Connecting Rod Journal Out - of - Round - Production	0.005 mm	0.0002 in
Connecting Rod Journal Out - of - Round - Service	0.01 mm	0.0004 in
Connecting Rod Journal Taper (Maximum for 1/2 of Journal Length - Production)	0.005 mm	0.0002 in
Connecting Rod Journal Taper (Maximum for 1/2 of Journal Length - Service)	0.02 mm	0.00078 in
Crankshaft End Play	0.04 mm 0.2 mm	0.0015 in 0.0078 in
Crankshaft Main Bearing Clearance - Production	0.02 mm 0.052 mm	0.0008 in 0.0021 in
Crankshaft Main Bearing Clearance - Service	0.02 mm 0.065 mm	0.0008 in 0.0025 in
Crankshaft Main Journal Diameter - Production	64.992 mm 65.008 mm	2.558 in 2.559 in
Crankshaft Main Journal Diameter - Service	64.992 mm	2.558 in
Crankshaft Main Journal Out - of - Round - Production	0.003 mm	0.000118 in
Crankshaft Main Journal Out - of - Round - Service	0.008 mm	0.0003 in

Crankshaft Main Journal Taper - Production	0.01 mm	0.0004 in
Crankshaft Main Journal Taper - Service	0.02 mm	0.00078 in
Crankshaft Rear Flange Runout	0.05 mm	0.002 in
Crankshaft Reluctor Ring Runout (Measured 1.0 mm (0.04 in) Below Tooth Diameter)	0.7 mm	0.028 in
Crankshaft Thrust Surface - Production	26.14 mm 26.22 mm	1.029 in 1.0315 in
Crankshaft Thrust Surface - Service	26.22 mm	1.0315 in
Crankshaft Thrust Surface Runout	0.025 mm	0.001 in
Cylinder Head		
Cylinder Head Height/Thickness (Measured from the Cylinder Head Deck to the Valve Rocker Arm Cover Seal Surface)	120.2 mm	4.732 in
Surface Flatness - Block Deck (Measured within a 152.4 mm (6.0 in) Area)	0.08 mm	0.003 in
Surface Flatness - Block Deck (Measuring the Overall Length of the Cylinder Head)	0.1 mm	0.004 in
Surface Flatness - Exhaust Manifold Deck	0.13 mm	0.005 in
Surface Flatness - Intake Manifold Deck	0.08 mm	0.0031 in
Valve Guide Installed Height (Measured from the Spring Seat Surface to the Top of the Guide)	17.32 mm	0.682 in
Intake Manifold		
Surface Flatness (Measured at Gasket Sealing Surfaces and Measured Within a 200 mm (7.87 in) Area that Includes 2 Runner Port Openings)	0.3 mm	0.118 in
Lubrication System		
Oil Capacity - with Filter	8.3 Litres	8.8 Quarts
Oil Pressure - Minimum - Hot	41 kPa at 1,000 engine RPM 124 kPa at 2,000 engine RPM 165 kPa at 4,000 engine RPM	6 psig at 1,000 engine RPM 18 psig at 2,000 engine RPM 24 psig at 4,000 engine RPM
Active Fuel Management Relief	379-517 kPa	55-75 psi

Valve Oil Pressure - as Measured at Oil Pressure Sensor Location	Maximum	Maximum
Oil Pan		
Front Cover Alignment - at Oil Pan Surface	0.0 mm 0.5 mm	0.0 in 0.02 in
Crankshaft Rear Oil Seal Housing Alignment - at Oil Pan Surface	0.0 mm 0.5 mm	0.0 in 0.02 in
Oil Pan Alignment - to Rear of Engine Block at Transmission Bell Housing Mounting Surface	0.0 mm 0.1 mm	0.0 in 0.004 in
Piston Rings		
Piston Ring End Gap - First Compression Ring (Measured in Cylinder Bore - Production)	0.20 mm 0.41 mm	0.008 in 0.016 in
Piston Ring End Gap - First Compression Ring (Measured in Cylinder Bore - Service)	0.20 mm 0.41 mm	0.008 in 0.016 in
Piston Ring End Gap - Second Compression Ring (Measured in Cylinder Bore - Production)	0.37 mm 0.69 mm	0.015 in 0.027 in
Piston Ring End Gap - Second Compression Ring (Measured in Cylinder Bore - Service)	0.37 mm 0.69 mm	0.015 in 0.027 in
Piston Ring End Gap - Oil Control Ring (Measured in Cylinder Bore - Production)	0.22 mm 0.79 mm	0.009 in 0.031 in
Piston Ring End Gap - Oil Control Ring (Measured in Cylinder Bore - Service)	0.22 mm 0.79 mm	0.009 in 0.031 in
Piston Ring to Groove Clearance - First Compression Ring - Production	0.030 mm 0.10 mm	0.0012 in 0.0040 in
Piston Ring to Groove Clearance - First Compression Ring - Service	0.030 mm 0.10 mm	0.0012 in 0.0040 in
Piston Ring to Groove Clearance - Second Compression Ring - Production	0.035 mm 0.078 mm	0.0014 in 0.0031 in
Piston Ring to Groove Clearance - Second Compression Ring - Service	0.035 mm 0.078 mm	0.0014 in 0.0031 in
Piston Ring to Groove Clearance - Oil Control Ring - Production	0.013 mm 0.201 mm	0.0005 in 0.0079 in
Piston Ring to Groove Clearance - Oil Control Ring - Service	0.013 mm 0.201 mm	0.0005 in 0.0079 in
Pistons and Pins		
Pin - Piston Pin Clearance to Piston Pin Bore - Production	0.002 mm 0.01 mm	0.0008 in 0.0004 in
Pin - Piston Pin Clearance to Piston		

Pin Bore - Service	0.002 mm 0.015 mm	0.0008 in 0.0006 in
Pin - Piston Pin Diameter	23.952 mm 23.955 mm	0.943 in 0.943 in
Pin - Piston Pin Fit in Connecting Rod Bore - Production	0.007 mm 0.02 mm	0.00027 in 0.00078 in
Pin - Piston Pin Fit in Connecting Rod Bore - Service	0.007 mm 0.022 mm	0.00027 in 0.00086 in
Piston - Piston Diameter - Measured Over Skirt Coating	101.611 mm 101.642 mm	4.0 in 4.001 in
Piston - Piston to Bore Clearance - Production	-0.022 mm 0.08 mm	-0.0009 in 0.0012 in
Piston - Piston to Bore Clearance (Service Limit with Skirt Coating Worn Off)	0.024 mm 0.08 mm	0.00094 in 0.0031 in
Valve System		
Valves - Valve Face Angle	45 degrees	
Valves - Valve Face Width	1.25 mm	0.05 in
Valves - Valve Lash	Net Lash - No Adjustment	
Valve Lift - Exhaust - Non Active Fuel Management	12.19 mm	0.480 in
Valve Lift - Exhaust - Active Fuel Management	12.41 mm	0.489 in
Valve Lift - Intake - Non Active Fuel Management	12.04 mm	0.474 in
Valve Lift - Intake - Active Fuel Management	12.24 mm	0.488 in
Valves - Valve Seat Angle	46 degrees	
Valves - Valve Seat Runout	0.05 mm	0.002 in
Valves - Valve Seat Width - Exhaust	1.78 mm	0.07 in
Valves - Valve Seat Width - Intake	1.02 mm	0.04 in
Valves - Valve Stem Diameter - Production	7.955-7.976 mm	0.313-0.314 in
Valves - Valve Stem Diameter - Service	7.95 mm	0.313 in
Valves - Valve Stem-to-Guide Clearance - Production - Exhaust	0.025-0.066 mm	0.001-0.0026 in
Valves - Valve Stem-to-Guide Clearance - Service - Exhaust	0.093 mm	0.0037 in
Valves - Valve Stem-to-Guide Clearance - Production - Intake	0.025-0.066 mm	0.001-0.0026 in
Valves - Valve Stem-to-Guide Clearance - Service - Intake	0.093 mm	0.0037 in
Rocker Arms - Valve Rocker Arm Ratio	1.70:1	
Valve Springs - Valve Spring Free Length	52.9 mm	2.08 in

Valve Springs - Valve Spring Installed Height	45.75 mm	1.8 in
Valve Springs - Valve Spring Load - Closed	340 N at 45.75 mm	76 lb at 1.8 in
Valve Springs - Valve Spring Load - Open	980 N at 33.55 mm	220 lb at 1.32 in

Engine Mechanical Specifications (6.2L LS3)

Application	Specification	
	Metric	English
General		
Engine Type	V8	
Displacement	6.2L	376 CID
RPO	LS3	
VIN	W	
Bore	103.241-103.259 mm	4.0065-4.0065 in
Stroke	92.0 mm	3.622 in
Compression Ratio	10.7:1	
Firing Order	1-8-7-2-6-5-4-3	
Spark Plug Gap	1.02 mm	0.04 in
Block		
Camshaft Bearing Bore 1 and 5 Diameter	59.58-59.63 mm	2.345-2.347 in
Camshaft Bearing Bore 2 and 4 Diameter	59.08-59.13 mm	2.325-2.327 in
Camshaft Bearing Bore 3 Diameter	58.58-58.63 mm	2.306-2.308 in
Crankshaft Main Bearing Bore Diameter	69.871-69.889 mm	2.75-2.751 in
Crankshaft Main Bearing Bore Out-of-Round	0.006 mm	0.0002 in
Cylinder Bore Diameter	103.241-103.259 mm	4.0065-4.0065 in
Cylinder Head Deck Height - Measuring from the Centerline of Crankshaft to the Deck Face	234.57-234.82 mm	9.235-9.245 in
Cylinder Head Deck Surface Flatness - Measured within a 152.4 mm (6.0 in) Area	0.11 mm	0.004 in
Cylinder Head Deck Surface Flatness - Measuring the Overall Length of the Block Deck	0.22 mm	0.008 in
Valve Lifter Bore Diameter	21.417-21.443 mm	0.843-0.844 in
Camshaft		
Camshaft End Play	0.025-0.305 mm	0.001-0.012 in
Camshaft Journal Diameter	54.99-55.04 mm	2.164-2.166 in
Camshaft Bearing Diameter	55.063-55.088 mm	2.1678-2.1688 in
Camshaft Journal-to-Bearing Clearance	0.023-0.098 mm	0.0009-0.0038 in
Camshaft Journal Out-of-Round	0.025 mm	0.001 in
Camshaft Lobe Lift - Intake	8.24 mm	0.324 in

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Camshaft Lobe Lift - Exhaust	7.77 mm	0.306 in
Camshaft Runout - Measured at the Intermediate Journals	0.05 mm	0.002 in
Connecting Rod		
Connecting Rod Bearing Clearance - Production	0.023-0.065 mm	0.0009-0.0025 in
Connecting Rod Bearing Clearance - Service	0.023-0.076 mm	0.0009-0.003 in
Connecting Rod Bore Diameter - Bearing End	56.505-56.525 mm	2.224-2.225 in
Connecting Rod Bore Out-of-Round - Bearing End - Production	0.004-0.008 mm	0.00015-0.0003 in
Connecting Rod Bore Out-of-Round - Bearing End - Service	0.004-0.008 mm	0.00015-0.0003 in
Connecting Rod Side Clearance	0.11-0.51 mm	0.00433-0.02 in
Crankshaft		
Connecting Rod Journal Diameter - Production	53.318-53.338 mm	2.0991-2.0999 in
Connecting Rod Journal Diameter - Service	53.308 mm	2.0987 in
Connecting Rod Journal Out-of-Round - Production	0.005 mm	0.0002 in
Connecting Rod Journal Out-of-Round - Service	0.01 mm	0.0004 in
Connecting Rod Journal Taper - Maximum for 1/2 of Journal Length - Production	0.005 mm	0.0002 in
Connecting Rod Journal Taper - Maximum for 1/2 of Journal Length - Service	0.02 mm	0.00078 in
Crankshaft End Play	0.04-0.2 mm	0.0015-0.0078 in
Crankshaft Main Bearing Clearance - Production	0.02-0.052 mm	0.0008-0.0021 in
Crankshaft Main Bearing Clearance - Service	0.02-0.065 mm	0.0008-0.0025 in
Crankshaft Main Journal Diameter - Production	64.992-65.008 mm	2.558-2.559 in
Crankshaft Main Journal Diameter - Service	64.992 mm	2.558 in
Crankshaft Main Journal Out-of-Round - Production	0.003 mm	0.000118 in
Crankshaft Main Journal Out-of-Round - Service	0.008 mm	0.0003 in
Crankshaft Main Journal Taper - Production	0.01 mm	0.0004 in
Crankshaft Main Journal Taper - Service	0.02 mm	0.00078 in
Crankshaft Rear Flange Runout	0.05 mm	0.002 in
Crankshaft Reluctor Ring Runout - Measured 1.0 mm (0.04 in) Below Tooth Diameter	0.7 mm	0.028 in
Crankshaft Thrust Surface - Production	26.14-26.22 mm	1.029-1.0315 in
Crankshaft Thrust Surface - Service	26.22 mm	1.0315 in
Crankshaft Thrust Surface Runout	0.025 mm	0.001 in
Cylinder Head		

Cylinder Head Height/Thickness - Measured from the Cylinder Head Deck to the Valve Rocker Arm Cover Seal Surface	120.2 mm	4.732 in
Surface Flatness - Block Deck - Measured within a 152.4 mm (6.0 in) Area	0.08 mm	0.003 in
Surface Flatness - Block Deck - Measuring the Overall Length of the Cylinder Head	0.1 mm	0.004 in
Surface Flatness - Exhaust Manifold Deck	0.13 mm	0.005 in
Surface Flatness - Intake Manifold Deck	0.08 mm	0.0031 in
Valve Guide Installed Height - Measured from the Spring Seat Surface to the Top of the Guide	17.32 mm	0.682 in
Intake Manifold		
Surface Flatness - Measured at Gasket Sealing Surfaces and Measured Within a 200 mm (7.87 in) Area that Includes 2 Runner Port Openings	0.3 mm	0.118 in
Lubrication System		
Oil Capacity - with Filter	8.3 liters	8.8 quarts
Oil Capacity - without Filter	5.4 liters	5.7 quarts
Oil Pressure - Minimum - Hot	41 kPa at 1,000 engine RPM 124 kPa at 2,000 engine RPM 165 kPa at 4,000 engine RPM	6 psig at 1,000 engine RPM 18 psig at 2,000 engine RPM 24 psig at 4,000 engine RPM
Oil Pan		
Front Cover Alignment - at Oil Pan Surface	0.0-0.5 mm	0.0-0.02 in
Crankshaft Rear Oil Seal Housing Alignment - at Oil Pan Surface	0.0-0.5 mm	0.0-0.02 in
Oil Pan Alignment - to Rear of Engine Block at Transmission Bell Housing Mounting Surface	0.0-0.1 mm	0.0-0.004 in
Piston Rings		
Piston Ring End Gap - First Compression Ring - Measured in Cylinder Bore - Production	0.17-0.38 mm	0.0067-0.0150 in
Piston Ring End Gap - First Compression Ring - Measured in Cylinder Bore - Service	0.17-0.44 mm	0.0067-0.0173 in
Piston Ring End Gap - Second Compression Ring - Measured in Cylinder Bore - Production	0.32-0.63 mm	0.0126-0.0248 in
Piston Ring End Gap - Second Compression Ring - Measured in Cylinder Bore - Service	0.32-0.69 mm	0.0126-0.0272 in
Piston Ring End Gap - Oil Control Ring - Measured in Cylinder Bore - Production	0.22-0.79 mm	0.0086-0.0311 in
Piston Ring End Gap - Oil Control Ring - Measured in Cylinder Bore - Service	0.22-0.85 mm	0.0086-0.0335 in
Piston Ring to Groove Clearance - First	0.030-0.083 mm	0.0012-

Compression Ring - Production		0.0033 in
Piston Ring to Groove Clearance - First Compression Ring - Service	0.030-0.083 mm	0.0012-0.0033 in
Piston Ring to Groove Clearance - Second Compression Ring - Production	0.040-0.083 mm	0.0016-0.0033 in
Piston Ring to Groove Clearance - Second Compression Ring - Service	0.040-0.083 mm	0.0016-0.0033 in
Piston Ring to Groove Clearance - Oil Control Ring - Production	0.013-0.201 mm	0.0005-0.0079 in
Piston Ring to Groove Clearance - Oil Control Ring - Service	0.013-0.201 mm	0.0005-0.0079 in
Pistons and Pins		
Pin - Piston Pin Clearance to Piston Pin Bore - Production	0.002-0.01 mm	0.00008-0.0004 in
Pin - Piston Pin Clearance to Piston Pin Bore - Service	0.002-0.015 mm	0.00008-0.0006 in
Pin - Piston Pin Diameter	23.952-23.955 mm	0.9430-0.9431 in
Pin - Piston Pin Fit in Connecting Rod Bore - Production	0.007-0.02 mm	0.00027-0.00078 in
Pin - Piston Pin Fit in Connecting Rod Bore - Service	0.007-0.022 mm	0.00027-0.00086 in
Piston - Piston Diameter - Measured Over Skirt Coating	103.258-103.289 mm	4.0653-4.0665 in
Piston - Piston to Bore Clearance - Production	-0.048 to +0.001 mm	-0.0019 to +0.000 in
Piston - Piston to Bore Clearance - Service Limit with Skirt Coating Worn Off	0.055 mm	0.0022 in
Valve System		
Valves - Valve Face Angle	45 degrees	
Valves - Valve Face Width	1.25 mm	0.05 in
Valves - Valve Lash	Net Lash - No Adjustment	
Valves - Valve Lift - Intake	13.97 mm	0.55 in
Valves - Valve Lift - Exhaust	13.22 mm	0.52 in
Valves - Valve Seat Angle	46 degrees	
Valves - Valve Seat Runout	0.05 mm	0.002 in
Valves - Valve Seat Width - Exhaust	1.78 mm	0.07 in
Valves - Seat Width - Intake	1.02 mm	0.04 in
Valves - Valve Stem Diameter - Production	7.955-7.976 mm	0.313-0.314 in
Valves - Valve Stem Diameter - Service	7.95 mm	0.313 in
Valves - Valve Stem-to-Guide Clearance - Production - Intake	0.025-0.066 mm	0.001-0.0026 in
Valves - Valve Stem-to-Guide Clearance - Service - Intake	0.093 mm	0.0037 in

Valves - Valve Stem-to-Guide Clearance - Production - Exhaust	0.025-0.066 mm	0.001-0.0026 in
Valves - Valve Stem-to-Guide Clearance - Service - Exhaust	0.093 mm	0.0037 in
Rocker Arms - Valve Rocker Arm Ratio	1.70:1	
Valve Springs - Valve Spring Free Length	52.9 mm	2.08 in
Valve Springs - Valve Spring Installed Height	45.75 mm	1.8 in
Valve Springs - Valve Spring Load - Closed	400 N at 45.75 mm	90 lb at 1.8 in
Valve Springs - Valve Spring Load - Open	1175 N at 33.05 mm	264 lb at 1.30 in

Engine Content Specifications

RPO	VIN	Displacement	Camshaft Position (CMP) Actuator Control System	Active Fuel Management Control System	E85 Capable	Block Material
L76	Y	6.0L	No	Yes	No	Aluminum
LS3	W	6.2L	No	No	No	Aluminum

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Adhesives, Fluids, Lubricants, and Sealers

Application	Type of Material	GM Part Number	
		United States	Canada
Coolant Temperature Sensor Threads	Sealant	12346004	10953480
Cylinder Head Core Hole Plugs	Threadlock	12345382	10953489
Cylinder Head Plug	Threadlock	12345382	10953489
Engine Block Coolant Drain Hole Plug Washer	Sealant	12346004	10953480
Engine Block Oil Gallery Plug - Front	Threadlock	12345382	10953489
Engine Block Oil Gallery Plug Washers	Sealant	12346004	10953480
Engine Oil	5W-30 Oil	12345610	729389
Engine Oil Pressure Sensor Threads	Sealant	12346004	10953480
Engine Oil Supplement	Fluorescent Dye	12345795	10953470
Exhaust Manifold Bolts	Threadlock	12345493	10953488
Flexplate/Flywheel Bolts	Threadlock	12345382	10953489
Fuel Injection Fuel Rail Bolts	Threadlock	12345382	10953489
Ignition Coil Bracket-to-Valve Cover Studs	Threadlock	12345382	10953489
Ignition Coil-to-Bracket Bolts	Threadlock	12345382	10953489
Intake Manifold Bolts	Threadlock	12345382	10953489
Oil Pan Surface at Front Cover and Rear Housing	Sealant	12378521	88901148
Thread Repair Component Cleaner	Cleaner	12346139	10953463
Thread Repair Component Cleaner	Cleaner	12377981	10953463
Thread Repair Cutting Oil	Lubricant	1052864	992881

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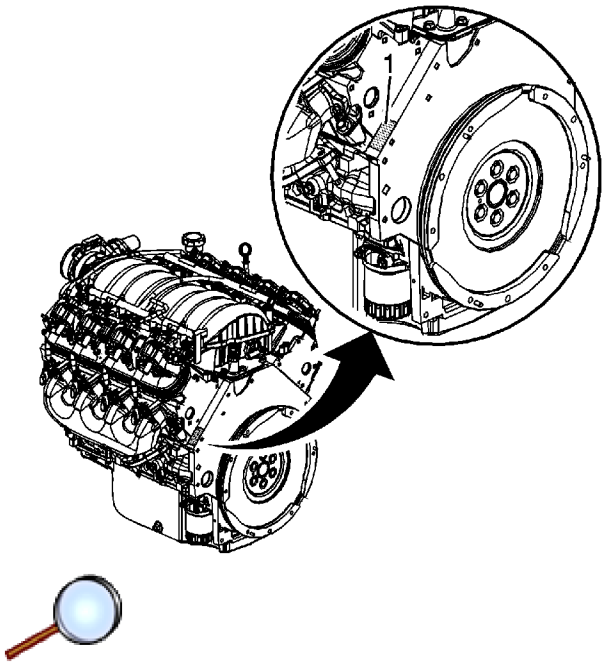
Engine Identification



The vehicle identification number (VIN) (1) is located on the left side rear of the engine block and is typically a 9 digit number stamped or laser-etched onto the engine at the vehicle assembly plant.

- The first digit identifies the division.
- The second digit identifies the model year.
- The third digit identifies the assembly plant.
- The fourth through ninth digits are the last 6 digits of the VIN.

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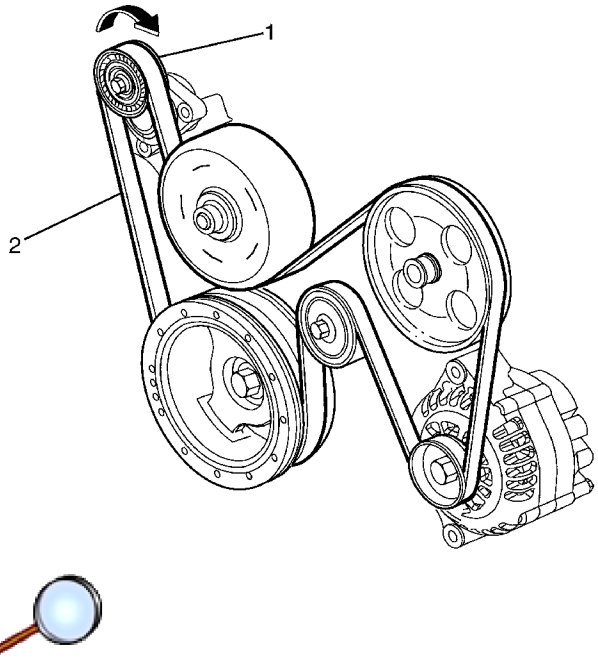
Drive Belt Replacement - Accessory

Removal Procedure

1. Remove the air intake duct. Refer to Air Cleaner Assembly Replacement.



2. Using a suitable tool, rotate the drive belt tensioner (1) clockwise to relieve the tension on the accessory drive belt (2).
3. Remove the accessory drive belt (2).
4. Slowly release tension on the drive belt tensioner (1).
5. Clean and inspect the drive belt surfaces of all the pulleys.

Installation Procedure

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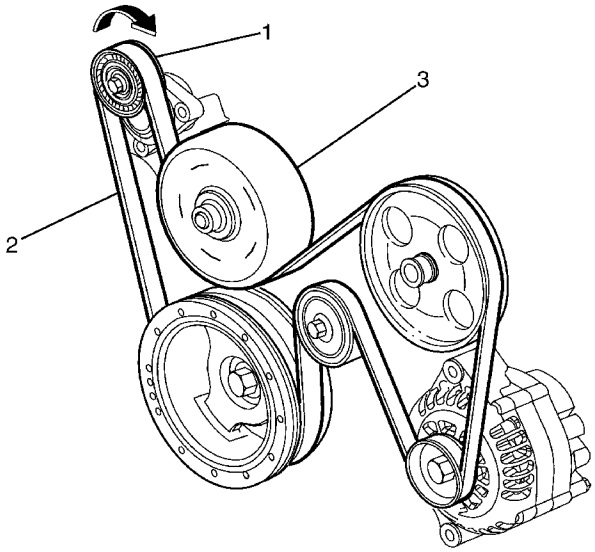
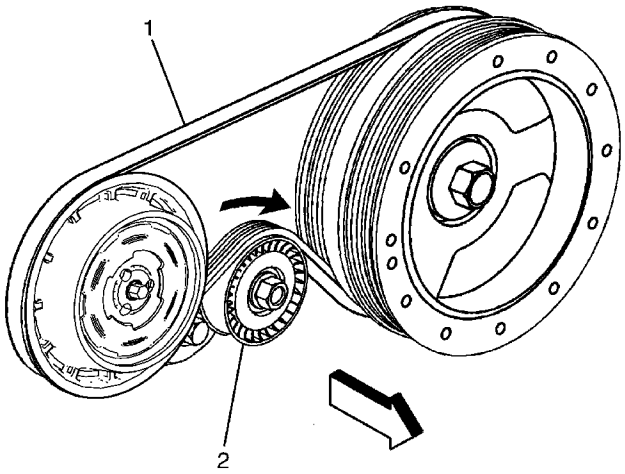


1. Route the accessory drive belt (2) around all the pulleys except the water pump pulley (3).
2. Using a suitable tool, rotate the drive belt tensioner (1) clockwise.
3. Install the accessory drive belt under the water pump pulley (3).
4. Slowly release the drive belt tensioner (1).
5. Install the air intake duct. Refer to Air Cleaner Assembly Replacement.
6. Inspect the accessory drive belt (2) for correct alignment.

Air Conditioning Compressor Belt Replacement

Removal Procedure

1. Remove the accessory drive belt. Refer to Drive Belt Replacement - Accessory.
2. Raise the vehicle. Refer to Lifting and Jacking the Vehicle.
3. Remove the Front Air Deflector. Refer to Front Air Deflector Replacement.



4. Using a suitable tool, rotate the air conditioner (A/C) belt tensioner (2) clockwise.
5. Remove the A/C belt (1).
6. Slowly release the A/C belt tensioner (2).
7. Clean and inspect the belt surfaces of all the pulleys.

Installation Procedure

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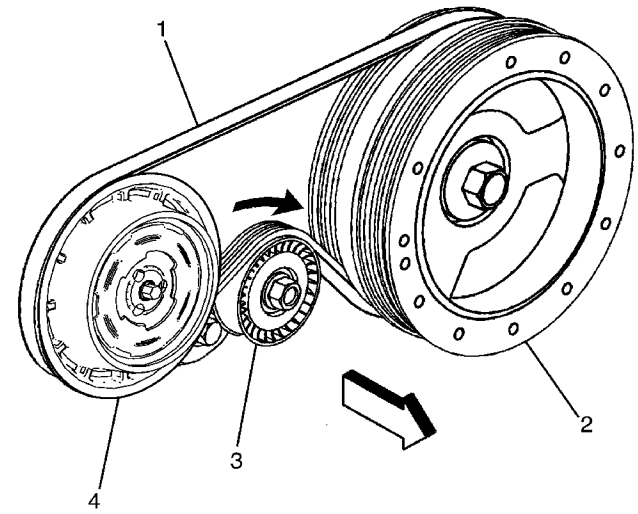
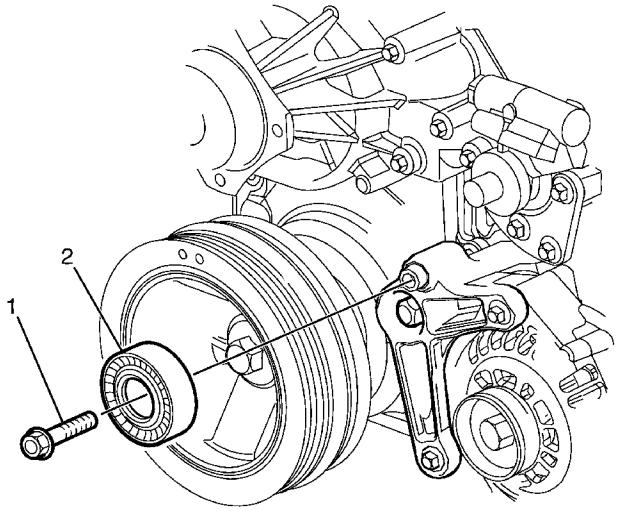


1. Install the A/C belt (1) around the crankshaft balancer (2).
2. Using a suitable tool, rotate the A/C belt tensioner (3) clockwise.
3. Install the A/C belt (1) over the A/C belt tensioner (3) idler pulley.
4. Install the A/C belt (1) around the A/C compressor pulley (4).
5. Slowly release the tension on the A/C belt tensioner (3).
6. Inspect the A/C belt (1) for correct installation and alignment.
7. Install the Front Air Deflector. Refer to Front Air Deflector Replacement.
8. Lower the vehicle.
9. Install the accessory drive belt. Refer to Drive Belt Replacement - Accessory.

Drive Belt Idler Pulley Replacement

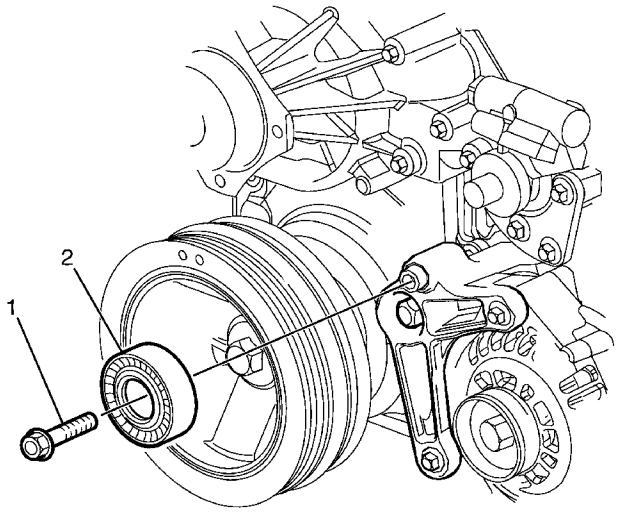
Removal Procedure

1. Remove the air intake duct. Refer to Air Cleaner Assembly Replacement.
2. Remove the accessory drive belt. Refer to Drive Belt Replacement - Accessory.



3. Remove the drive belt idler pulley to alternator bracket retaining bolt (1).
4. Remove the drive belt idler pulley (2).

Installation Procedure



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1. Install the drive belt idler pulley (2).
2. Hand tighten the drive belt idler pulley to alternator bracket retaining bolt (1).

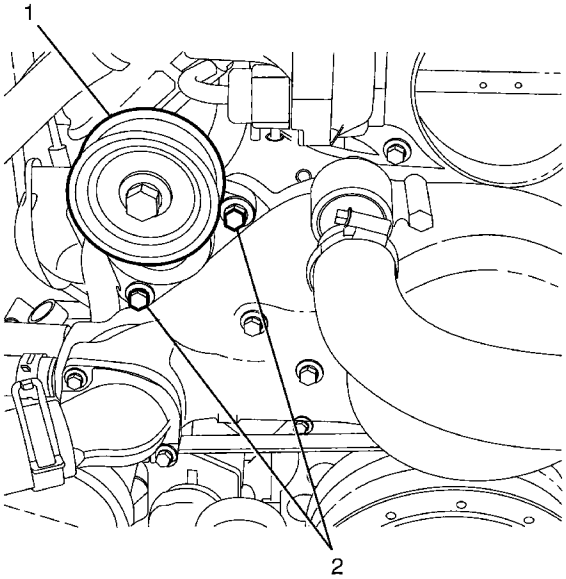
Caution: Refer to Fastener Caution in the Preface section.

3. Tighten the drive belt idler pulley bolt to **58 N·m (43 lb ft)**.
4. Install the accessory drive belt. Refer to Drive Belt Replacement - Accessory.
5. Install the air intake duct. Refer to Air Cleaner Assembly Replacement.

Drive Belt Tensioner Replacement - Accessory

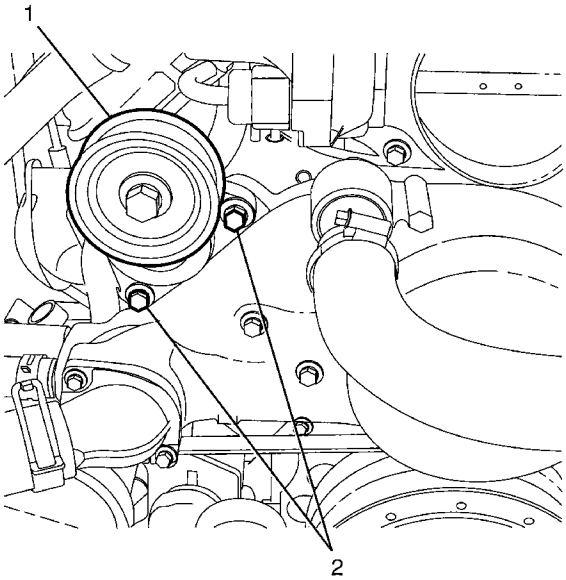
Removal Procedure

1. Remove the air intake duct. Refer to Air Cleaner Assembly Replacement.
2. Remove the accessory drive belt. Refer to Drive Belt Replacement - Accessory.



3. Remove the accessory drive belt tensioner to cylinder head retaining bolts (2).
4. Remove the accessory drive belt tensioner (1).

Installation Procedure



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1. Install the accessory drive belt tensioner (1).

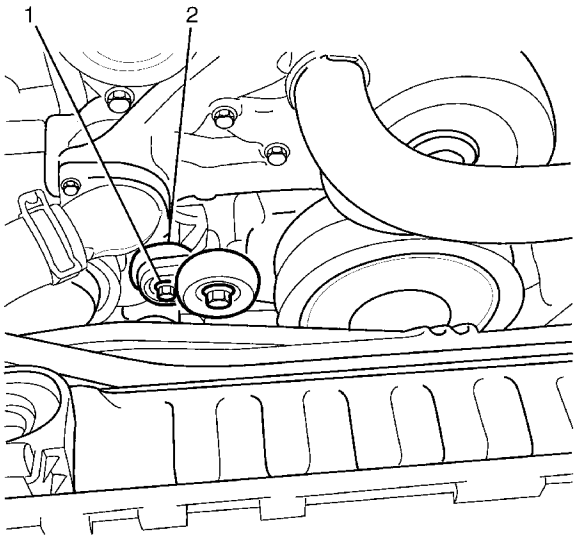
   Caution: Refer to Fastener Caution in the Preface section.

2. Install the accessory drive belt tensioner to cylinder head retaining bolts (2) and tighten to **58 N·m (43 lb ft)**.
3. Install the accessory drive belt. Refer to Drive Belt Replacement - Accessory.
4. Install the air intake duct. Refer to Air Cleaner Assembly Replacement.

Drive Belt Tensioner Replacement - Air Conditioning

Removal Procedure

1. Remove the air intake duct. Refer to Air Cleaner Assembly Replacement.
2. Remove the accessory drive belt. Refer to Drive Belt Replacement - Accessory.
3. Remove the air conditioning (A/C) drive belt. Refer to Air Conditioning Compressor Belt Replacement.



4. Remove the A/C drive belt tensioner to A/C compressor bracket retaining bolt (1).
5. Remove the A/C drive belt tensioner (2).

Installation Procedure

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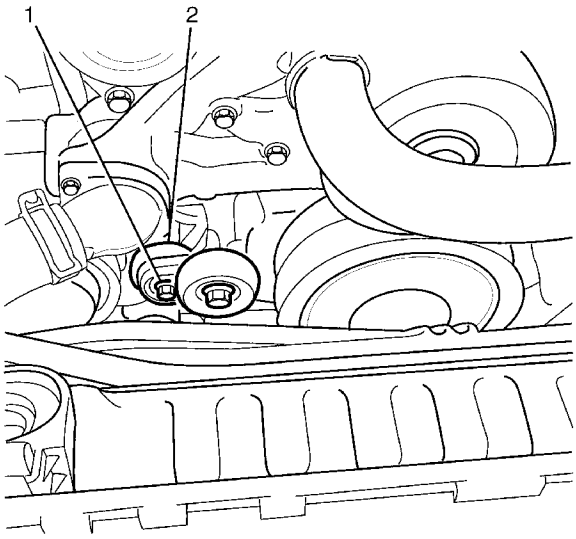


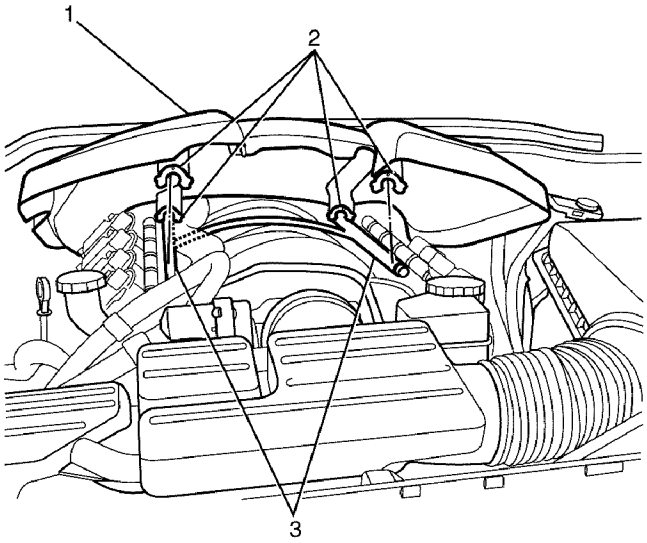
1. Install the A/C drive belt tensioner (2).

   Caution: Refer to Fastener Caution in the Preface section.

2. Tighten the A/C drive belt tensioner to A/C compressor bracket retaining bolt (1) to **22 N·m (16 lb ft)**.
3. Install the air conditioning (A/C) drive belt. Refer to Air Conditioning Compressor Belt Replacement.
4. Install the accessory drive belt. Refer to Drive Belt Replacement - Accessory.
5. Install the air intake duct. Refer to Air Cleaner Assembly Replacement.

Engine Cover Replacement

Removal Procedure



Important: Pull upward on the front of the engine cover (1) to detach the engine cover to fuel injector rail retaining clips (2).

1. Detach the engine cover (1) from the fuel rail (3).
2. Remove the engine cover (1) from the engine compartment.

Installation Procedure

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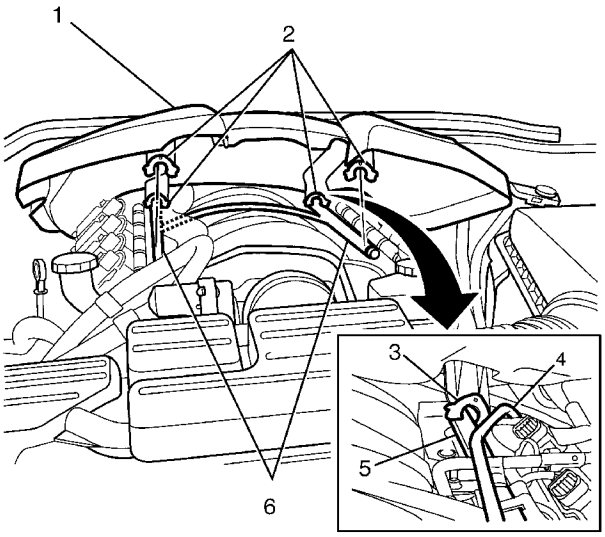

Important: Lower the rear of the engine cover (1) to the engine and align the engine cover to fuel injector rail retaining clips (2) to the fuel rail (6).

Important: Make sure that the engine cover retainer (3) correctly engages the fuel rail (5), clear of the PCV hose (4).

1. Position the engine cover (1) to the fuel rail (6).

Important: Press down on the engine cover (1) to ensure the engine cover to fuel injector rail retaining clips (2) are fully engaged to prevent an induced rattle condition.

2. Install the engine cover (1) to the fuel rail (6).

Engine Mount Inspection

Caution: Broken or deteriorated mounts can cause misalignment and destruction of certain drive train components. When a single mount breaks, the remaining mounts are subjected to abnormally high stresses.

Note: Raising the engine, will remove the weight from the engine mount and create a slight tension in the rubber mount.

1. Use a suitable engine lifting tool to raise the engine until the weight of the engine is removed from the engine mounts.

   Note: Before replacing any engine mount due to suspected fluid loss, verify that the source of the fluid is actually the engine mount, not the engine or other accessories.

2. Observe the engine mount while raising the engine. Replace the engine mount if the mount exhibits any of the following conditions:
   - The hard rubber surface is covered with heat check cracks.
   - The rubber is separated from the metal plate of the engine mount.
   - The rubber is split through the centre of the engine mount.
   - The GLYCOL™ fluid is leaking from the engine mount.
3. If there is movement between the metal plate of the engine mount and its attaching points, lower the engine on the engine mount. Tighten the bolts or nuts attaching the engine mount to the frame or engine mount bracket. Refer to Engine Mount Replacement - Left Side or Engine Mount Replacement - Right Side.

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Engine Mount Replacement - Left Side

Special Tools

- J 28467-B Universal Engine Support Fixture
- J 41803 Engine Support Fixture
- J 41798 Engine Lift Bracket

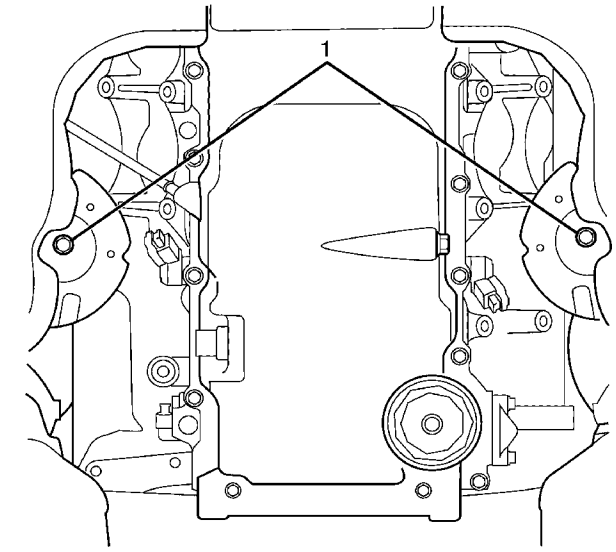
Removal Procedure

1. Remove the engine cover. Refer to Engine Cover Replacement.

   Warning: Refer to Safety Glasses Warning in the Preface section.

   Danger: To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

2. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
3. Remove the engine splash shield. Refer to Engine Splash Shield Replacement.



4. Remove the lower engine mount to front sub-frame retaining nut (1) from both engine mounts.
5. Lower the vehicle.

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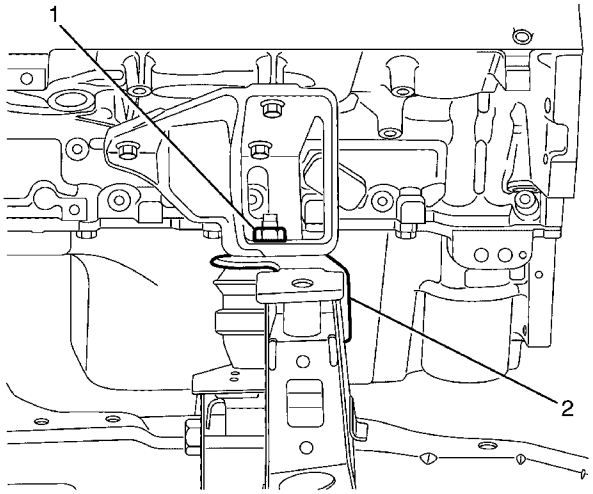
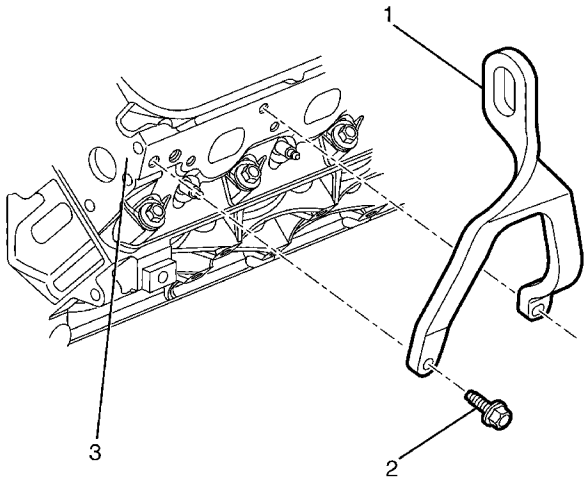


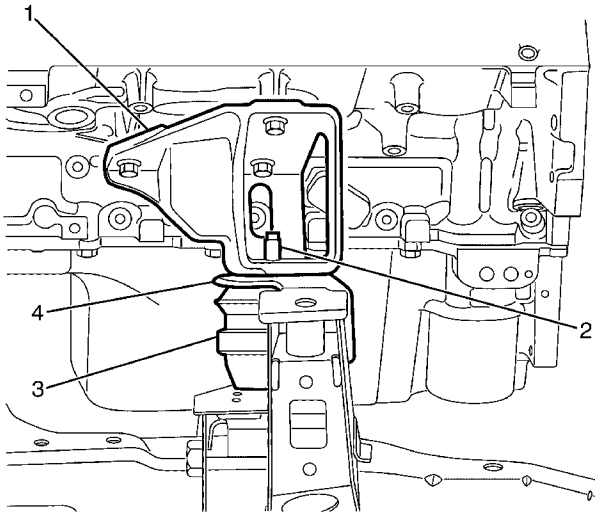
6. Remove the upper left side engine mount to engine mount bracket retaining nut (1).



7. Position the J 41798 (1) on the cylinder head (3).

Caution: Refer to Fastener Caution in the Preface section.

8. Install the J 41798 to cylinder head retaining bolts (2) and tighten to **50 N·m (36 lb ft)**.



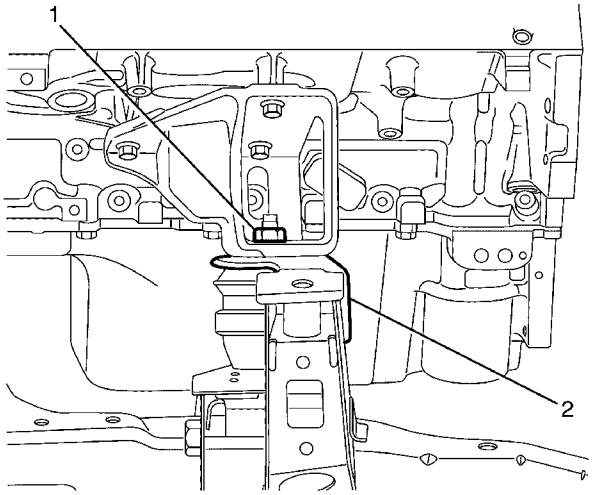
Note: When lifting the engine assembly, observe the clearance between the rear of the engine assembly and the dash panel.

9. Install J 41803 and J 28467-B and raise the engine assembly until the left side engine mount bracket (1) is clear of the left side engine mount retaining stud (2).

Note: DO NOT bend or distort the right side engine mount heat shield (4).

10. Remove the left side engine mount assembly (3).

Installation Procedure

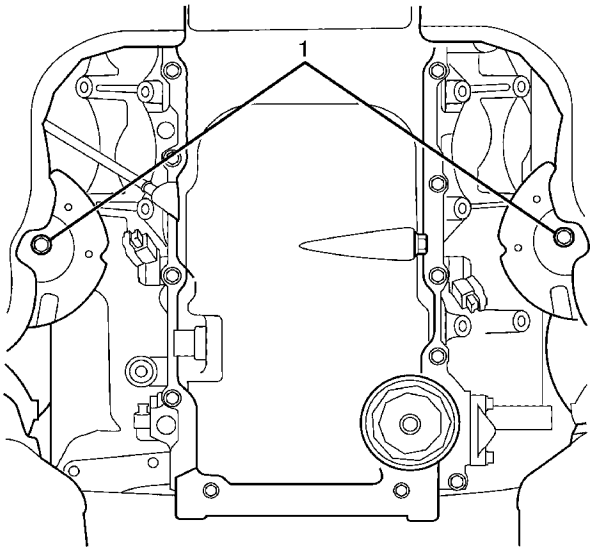


Note: DO NOT bend or distort the right side engine mount heat shield (4).

1. Position the left side engine mount assembly (3).
2. Lower the engine and remove J 41803 , J 28467-B and J 41798 from the engine.

Caution: Refer to Fastener Caution in the Preface section.

3. Install the upper engine mount to engine mount bracket retaining nut (1) and tighten to **80 N·m (59 lb ft)**.



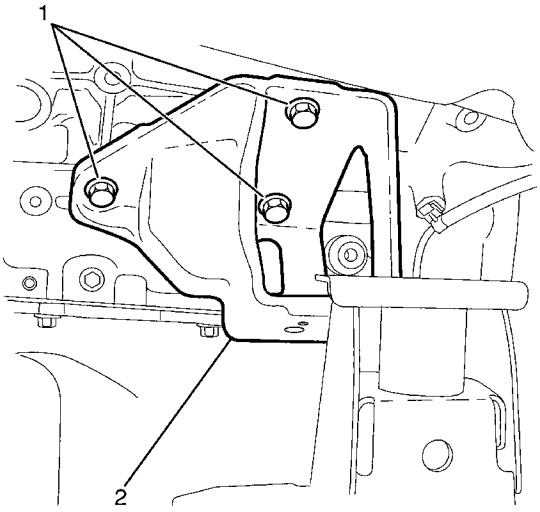
Danger: To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

4. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
5. Install the lower engine mount to front sub-frame retaining nut (1) on both engine mounts and tighten to **80 N·m (59 lb ft)**.
6. Install the engine splash shield. Refer to Engine Splash Shield Replacement.
7. Lower the vehicle.
8. Install the engine splash shield. Refer to Engine Cover Replacement.

Engine Mount Bracket Replacement - Left Side

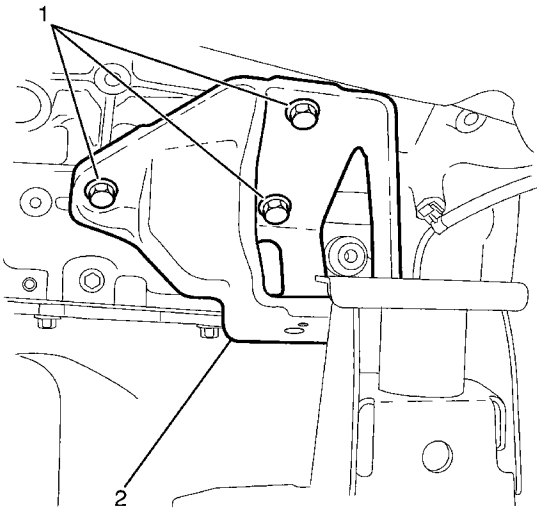
Removal Procedure

1. Remove the left side engine mount. Refer to Engine Mount Replacement - Left Side.



2. Remove the left side engine mount bracket to cylinder block retaining bolts (1).
3. Remove the left side engine mount bracket (2).

Installation Procedure



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1. Install the left side engine mount bracket (2).

   Caution: Refer to Fastener Caution in the Preface section.

2. Install the left side engine mount bracket to cylinder block retaining bolts (1) and tighten to **50 N·m (37 lb ft)**.
3. Install the left side engine mount. Refer to Engine Mount Replacement - Left Side.

Engine Mount Replacement - Right Side

Special Tools

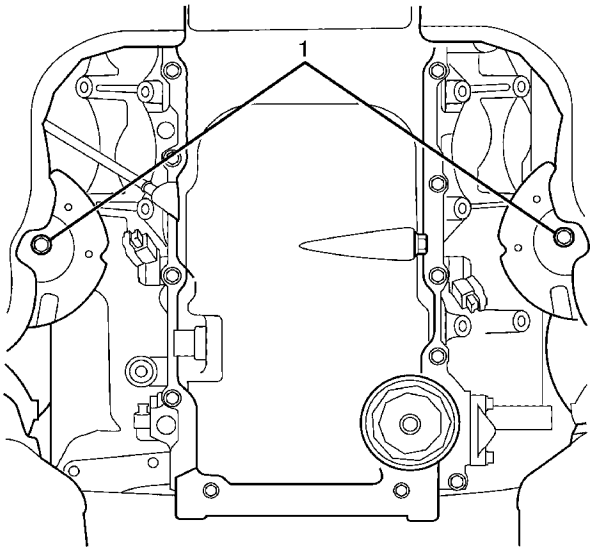
- J 28467-B Universal Engine Support Fixture
- J 41803 Engine Support Fixture
- J 41798 Engine Lift Bracket

Removal Procedure

1. Remove the engine cover. Refer to Engine Cover Replacement.
2. Remove the oil level indicator and tube. Refer to Oil Level Indicator and Tube Replacement.

Danger: To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

3. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
4. Remove the engine splash shield. Refer to Engine Splash Shield Replacement.



5. Remove the lower engine mount to front sub-frame retaining nut (1) from both engine mounts.
6. Lower the vehicle.

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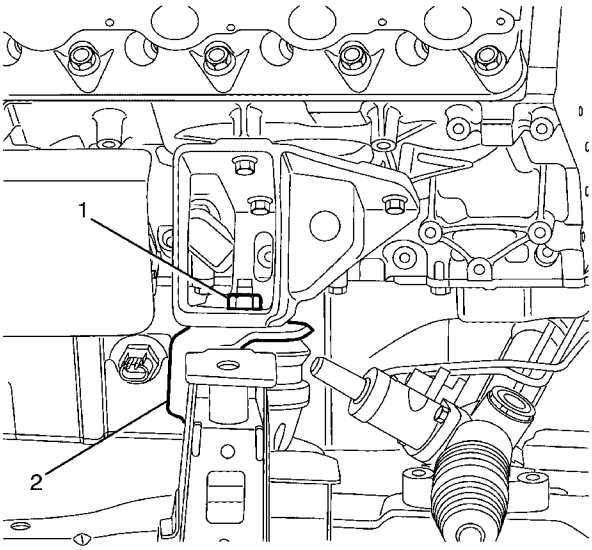
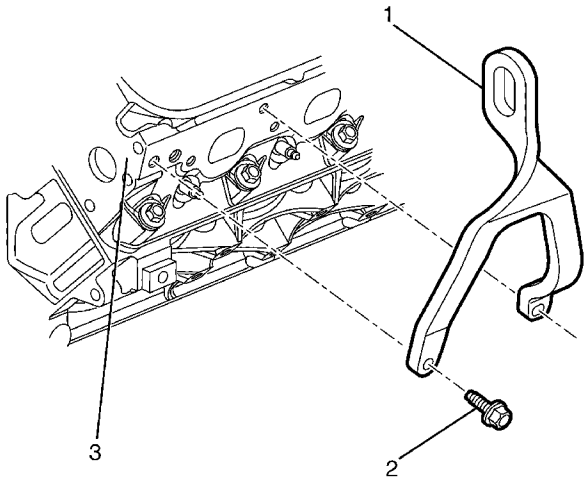


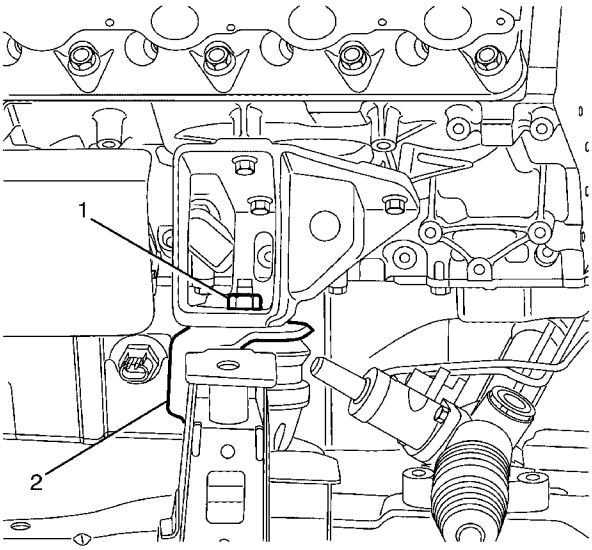
7. Remove the upper right side engine mount to engine mount bracket retaining nut 1).



8. Position the J 41798 (1) on the cylinder head (3).

Caution: Refer to Fastener Caution in the Preface section.

9. Install the J 41798 to cylinder head retaining bolts (2) and tighten to **50 N·m (36 lb ft)**.



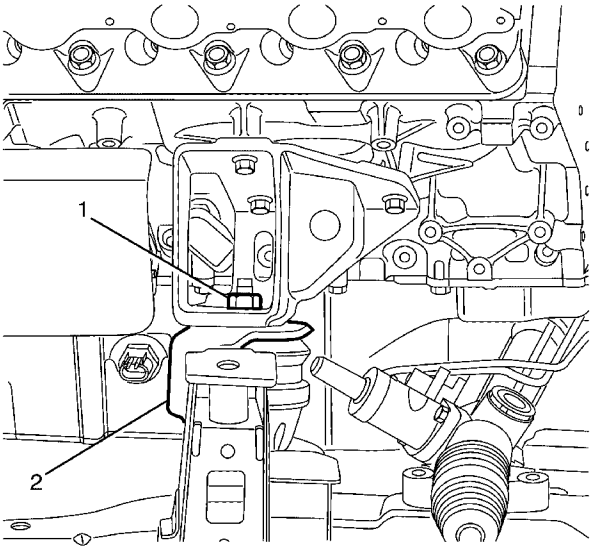
Note: When lifting the engine assembly, observe the clearance between the rear of the engine assembly and the dash panel.

10. Install J 41803 and J 28467-B and raise the engine assembly until the right side engine mount bracket (1) is clear of the right side engine mount retaining stud (2).

Note: DO NOT bend or distort the right side engine mount heat shield (4).

11. Remove the right side engine mount assembly (3).

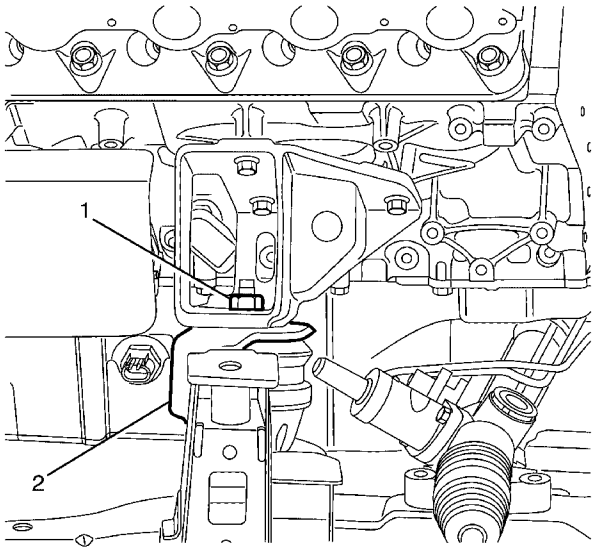
Installation Procedure



Note: DO NOT bend or distort the right side engine mount heat shield (4).

1. Install the right side engine mount assembly (3).
2. Lower the engine assembly until the right side engine mount retaining stud (2) is installed through the right side engine mount bracket (1).
3. Remove J 41803 , J 28467-B and J 41798 from the engine.

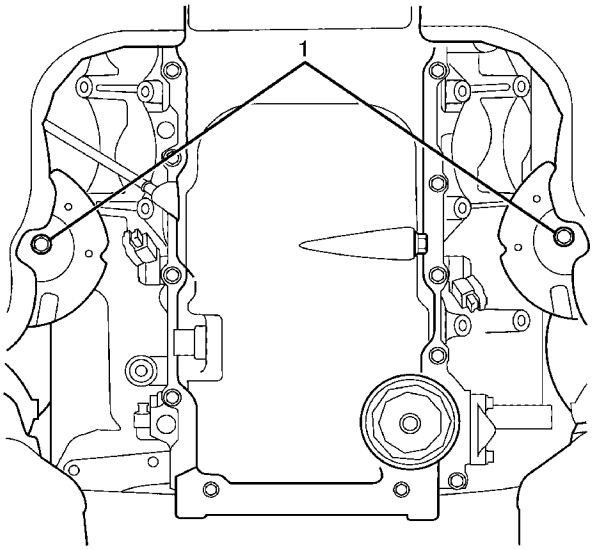
Caution: Refer to Fastener Caution in the Preface section.



4. Install the upper right side engine mount to engine mount bracket retaining nut (1) and tighten to **80 N·m (59 lb ft)**.

Danger: To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

5. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.



6. Install the lower engine mount to front sub-frame retaining nut (1) on both engine mounts and tighten to **80 N·m (59 lb ft)**.
7. Install the engine splash shield. Refer to Engine Splash Shield Replacement.
8. Lower the vehicle.
9. Install the oil level indicator and tube. Refer to Oil Level Indicator and Tube Replacement.
10. Install the engine cover. Refer to Engine Cover Replacement.

Engine Mount Bracket Replacement - Right Side

Removal Procedure

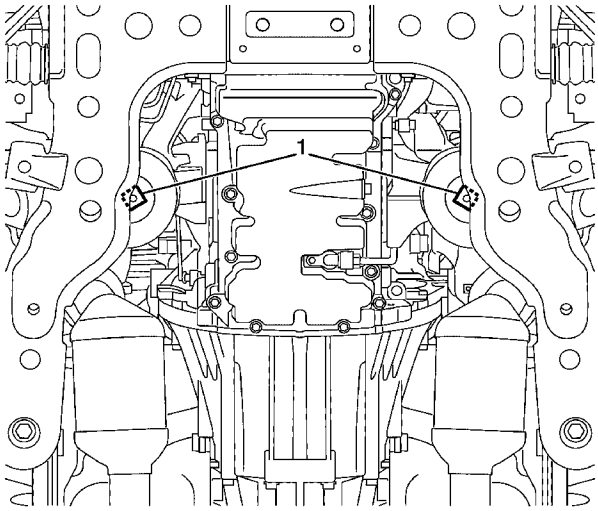
Special Tools

EN 46114 Engine Lift Brackets

Warning: Refer to Safety Glasses Warning in the Preface section.

Danger: To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
2. Remove the engine splash shield. Refer to Engine Splash Shield Replacement.



3. Remove the lower engine mount retaining nuts (1).
4. Lower the vehicle.

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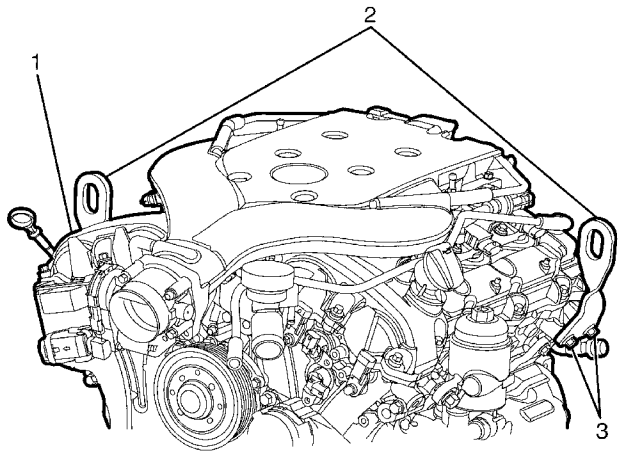


5. Position the EN 46114 (2) on the engine (1).

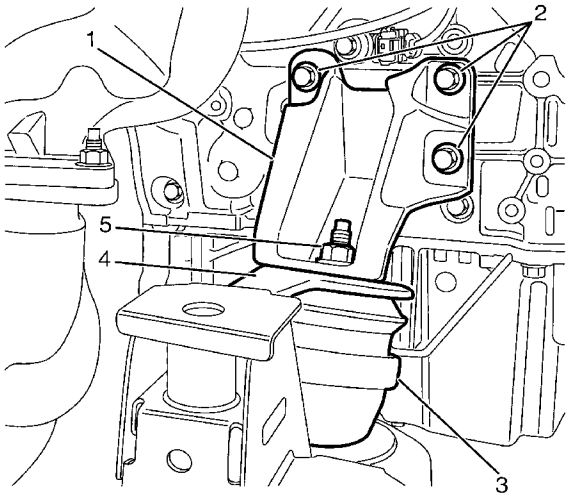
Caution: Refer to Fastener Caution in the Preface section.

6. Install the EN 46114 to cylinder head retaining bolts (3) and tighten to **50 N·m (36 lb ft)**.

Note: Use a suitable tool to raise the engine.

Note: When lifting the engine assembly, observe the clearance between the rear of the engine assembly and the dash panel.

7. Raise the engine until the weight of the engine is removed from the right hand engine mount.



8. Remove the right hand engine mount to engine mount bracket retaining nut (5).

   Important: If required, raise the engine further to provide adequate space.

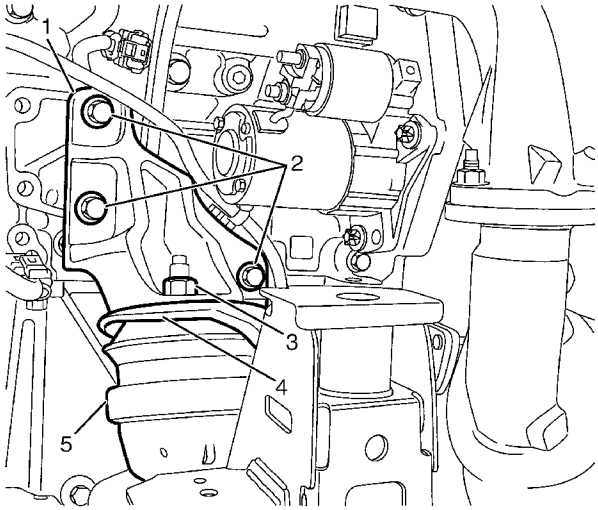
   Important: When lifting the engine assembly, observe the clearance between the rear of the engine assembly and the dash panel.

9. Remove the right hand engine mount (3) from the right hand engine mount bracket (1).

   Note: DO NOT distort or bend the right hand engine mount heat shield (4).

10. Remove the right hand engine mount bracket to cylinder block retaining bolts (2).
11. Remove the right hand engine mount bracket (1).

Installation Procedure



Note: DO NOT distort or bend the right hand engine mount heat shield (4).

1. Install the right hand engine mount bracket (1).

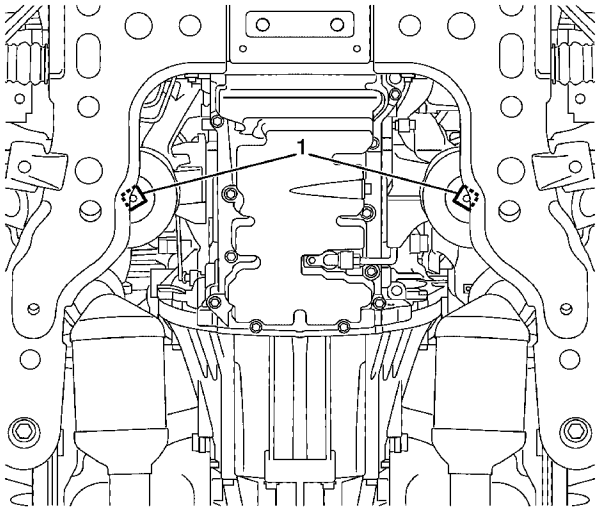
   Caution: Refer to Fastener Caution in the Preface section.

2. Install the right hand engine mount bracket to cylinder block retaining bolts (2) and tighten to **60 N·m (44 lb ft)**.
3. Position the right hand engine mount (3) on the right hand engine mount bracket (1).
4. Install the right hand engine mount to engine mount bracket retaining nut (5) and tighten to **80 N·m (59 lb ft)**.
5. Lower the engine until the weight is resting on the right hand engine mount.

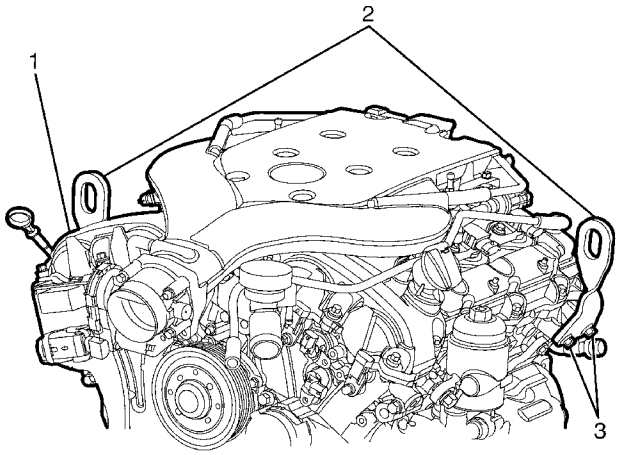
   Warning: Refer to Safety Glasses Warning in the Preface section.

Danger: To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

6. Raise the vehicle.



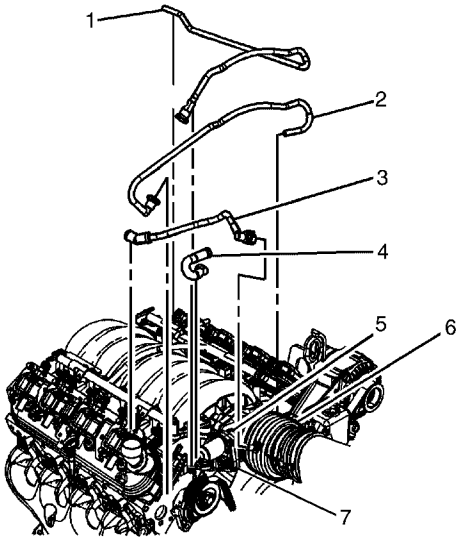
7. Install the engine mount to front sub-frame retaining nut (1) and tighten to **80 N·m (59 lb ft)**.
8. Install the engine splash shield. Refer to Engine Splash Shield Replacement.
9. Lower the vehicle to the ground.



10. Remove the EN 46114 to cylinder head retaining bolts (3).
11. Remove the EN 46114 (2) from the engine (1).

Positive Crankcase Ventilation Hose / Pipe / Tube Replacement

Removal Procedure



1. Remove the engine cover. Refer to Engine Cover Replacement.

   Important: In the following service procedure, it maybe necessary to remove the evaporative emission (EVAP) valve assembly to gain access to the positive crankcase ventilation hose.

2. Remove the evaporative emission canister purge valve (5). Refer to Evaporative Emission Canister Purge Solenoid Valve Replacement.
3. Remove the EVAP pipes (1) and (2).
4. Remove the EVAP pipe (3) from the air intake duct (6) and the valve cover.
5. Remove the hose (4) from the throttle body (7) and the engine valley cover.

Installation Procedure

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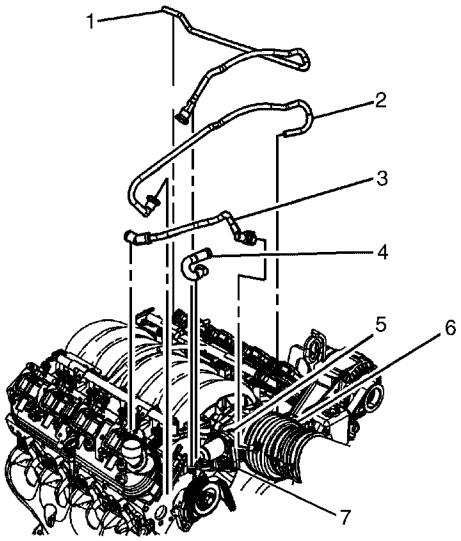


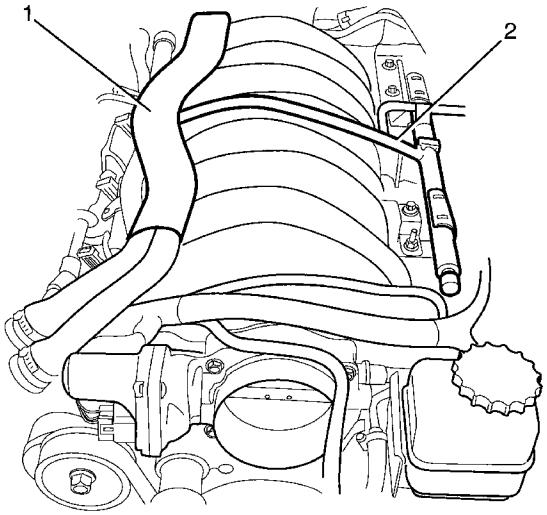
1. Install the hose (4) from the throttle body (7) and the engine valley cover.
2. Install the EVAP pipe (3) from the air intake duct (6) and the valve cover.
3. Install the evaporative emission canister purge valve (5). Refer to Evaporative Emission Canister Purge Solenoid Valve Replacement.
4. Install the EVAP pipes (1) and (2).
5. Install the engine cover. Refer to Engine Cover Replacement.

Intake Manifold Replacement

Removal Procedure

Important: The intake manifold, throttle body, fuel injection rail, and injectors may be removed as an assembly. If not servicing the individual components, remove the manifold as a complete assembly.

1. Remove the engine cover. Refer to Engine Cover Replacement.
2. Depressurize the fuel system. Refer to Fuel Pressure Relief.
3. Disconnect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection .
4. Drain the cooling system. Refer to Cooling System Draining and Filling.
5. Remove the air intake duct. Refer to Air Cleaner Inlet Duct Replacement .



6. Reposition and secure the heater hoses (1) away from the intake manifold (2).

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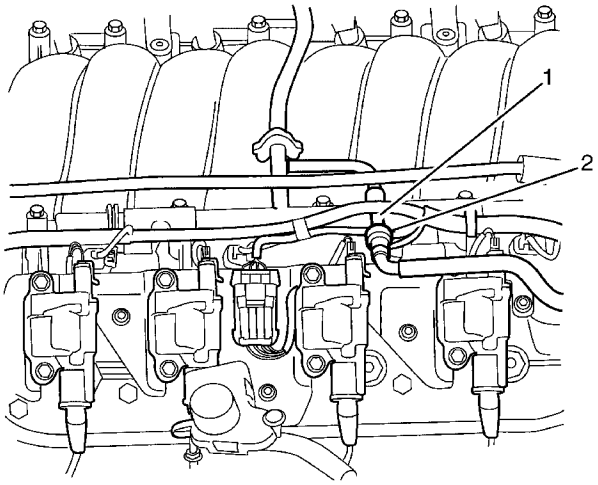
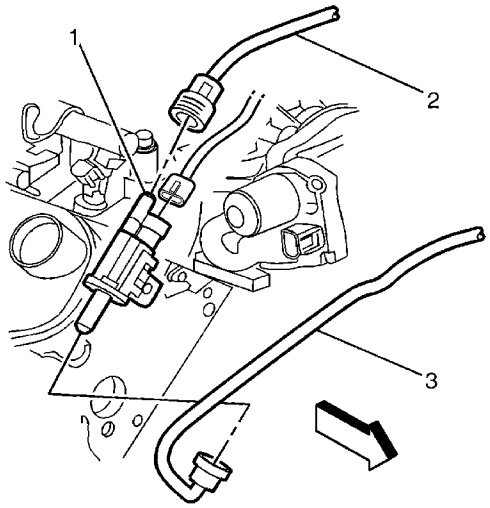


Important: Plug or cap the fuel feed pipe (2) and fuel rail tube (1) ends to prevent fuel leaks and/or contamination.

7. Disconnect the fuel rail feed pipe (2) quick connect fitting. Refer to Metal Collar Quick Connect Fitting Service or Plastic Collar Quick Connect Fitting Service.



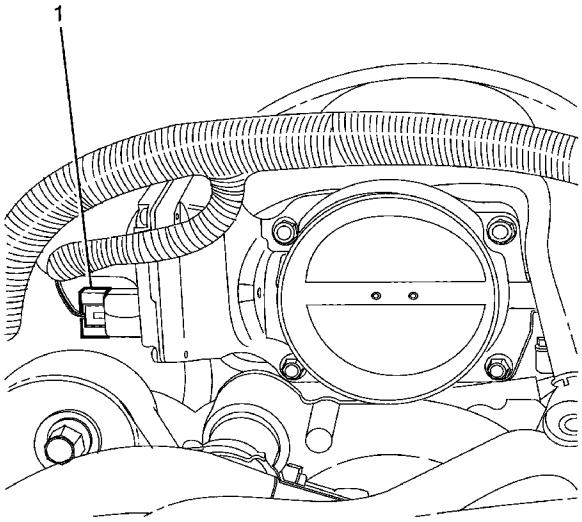
Important: Plug or cap the throttle body to EVAP purge valve hose (3) and EVAP purge valve (1) ends to prevent fuel leaks and/or contamination.

8. Disconnect the throttle body to EVAP purge valve hose (3) from the EVAP purge valve (1).

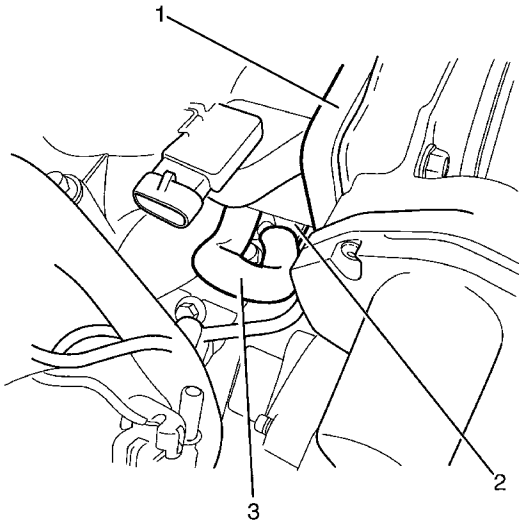
Important: Plug or cap the EVAP purge valve to fuel tank hose (2) and EVAP purge valve (1)

ends to prevent fuel leaks and/or contamination.

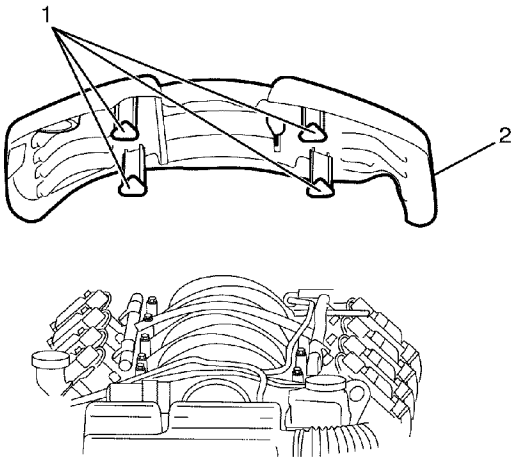
9. Disconnect the EVAP purge valve to fuel tank hose (2) from the EVAP purge valve (1).



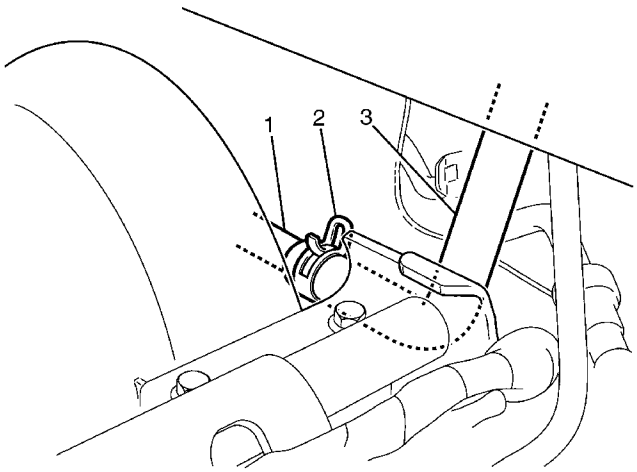
10. Disconnect the electronic throttle body wiring harness connector (1).



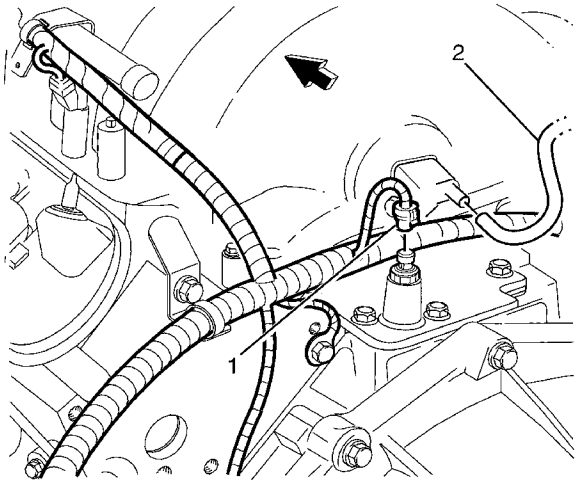
11. Disconnect the (PCV) Positive Crankcase Ventilation hose (3) from the intake manifold (1) and the valley cover (2).



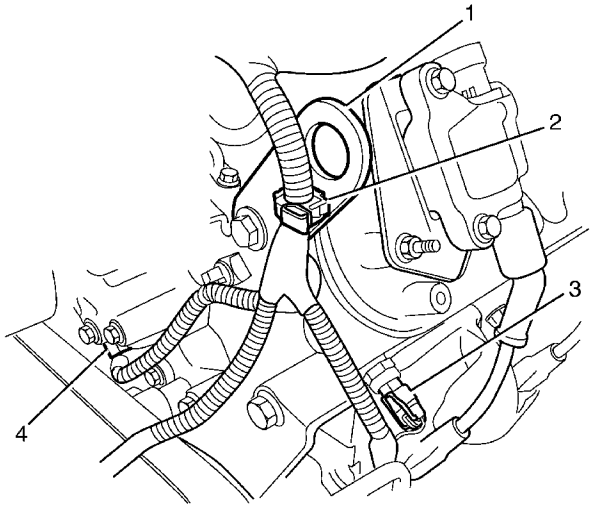
12. Disconnect the alternator wiring harness connector (1) from the alternator.



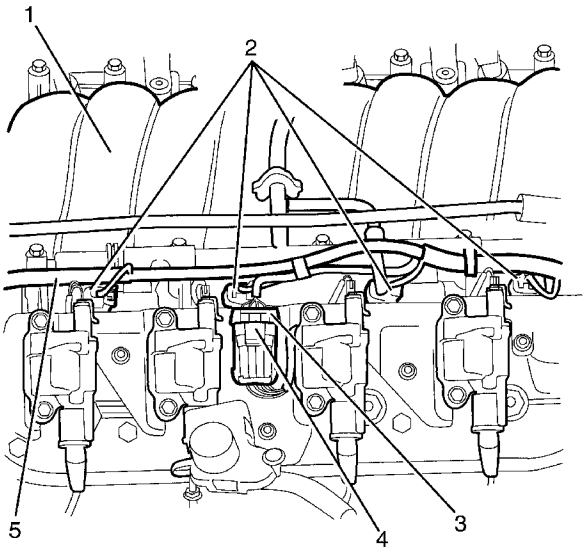
13. Compress the vacuum hose retaining clamp (2) at the intake manifold vacuum port (1) and slide 50 mm (2 in) back along the vacuum hose (3).
14. Disconnect the vacuum hose (3) from the intake manifold vacuum port (1).



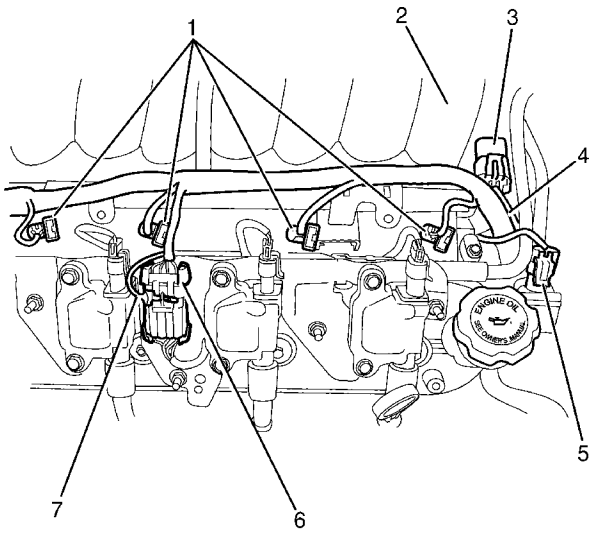
15. Disconnect the oil pressure sensor wiring harness connector (1) from the oil pressure sensor.
16. Disconnect the HVAC vacuum hose (2) from the intake manifold.



17. Disconnect the camshaft position sensor connector (4) from the camshaft position sensor.
18. Disconnect the coolant temperature sensor connector (3) from the coolant temperature sensor.
19. Detach the wiring harness retaining clip (2) from the engine lifting bracket (1).



20. Disconnect the left side fuel injector wiring harness connectors (2) from the fuel injectors.
21. Remove the Connector Position Assurance (CPA) lock (4) from the left side ignition coil main connector (3).
22. Disconnect the left side ignition coil main connector (3) from the ignition coil wiring harness.
23. Reposition and secure the left side fuel injector wiring harness (5) away from the intake manifold (1).

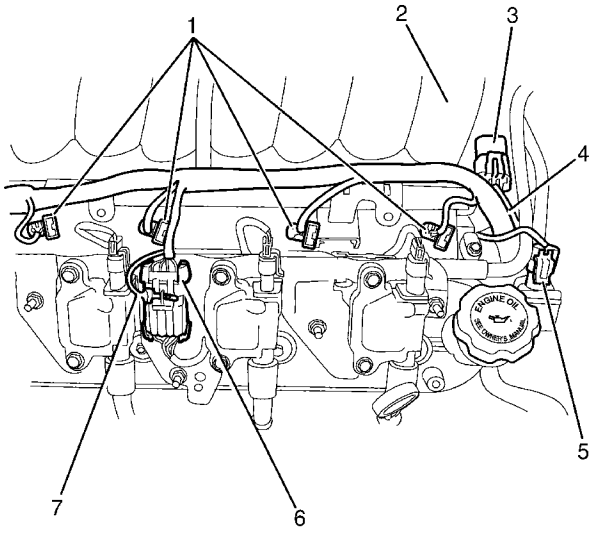


24. Disconnect the right side fuel injector wiring harness connectors (1) from the fuel injectors.
25. Remove the CPA lock (7) from the right side ignition coil main connector (6).
26. Disconnect the right side ignition coil main connector (6) from the ignition coil wiring harness.
27. Disconnect the canister purge valve (5) wiring harness connector.
28. Disconnect the manifold absolute pressure (MAP) sensor wiring harness connector (3) from the MAP sensor.
29. Reposition and secure the right side fuel injector wiring harness (4) away from the intake

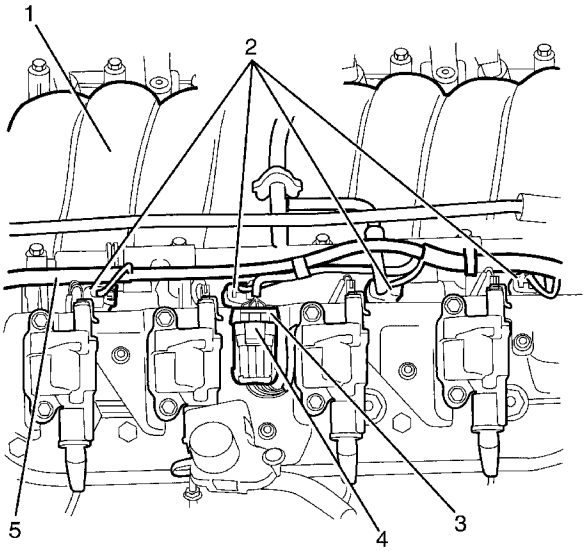
manifold (2).
30. Remove the intake manifold. Refer to Intake Manifold Removal.
31. Clean and inspect the intake manifold. Refer to Intake Manifold Cleaning and Inspection.

Installation Procedure

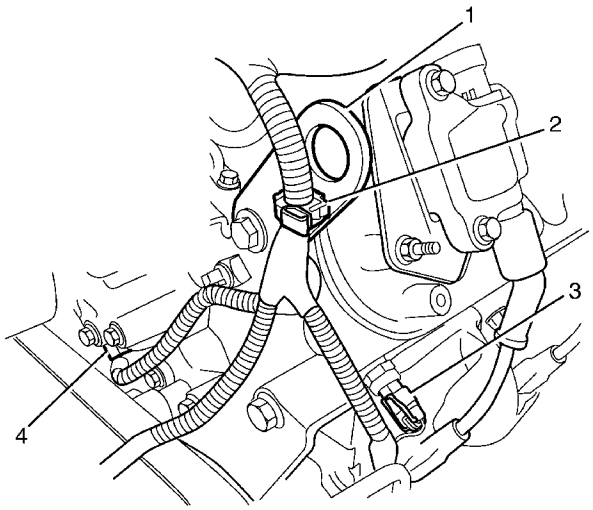
1. Install the intake manifold. Refer to Intake Manifold Installation.



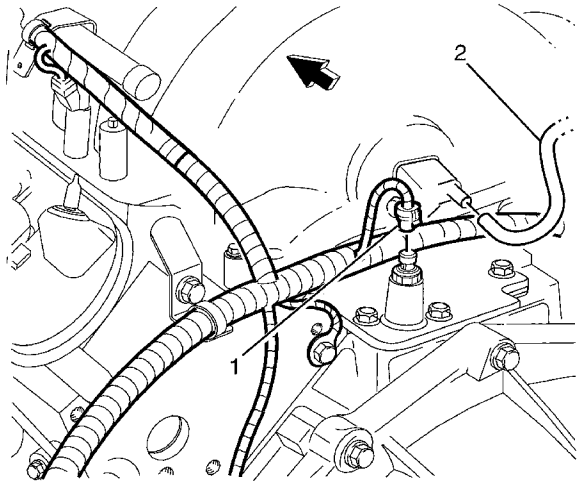
2. Position the right side fuel injector wiring harness (4) on the intake manifold (2).
3. Connect the Manifold Absolute Pressure (MAP) sensor wiring harness connector (3) to the MAP sensor.
4. Connect the canister purge valve wiring harness connector (5).
5. Connect the right side ignition coil main connector (6) to the ignition coil wiring harness.
6. Install the Connector Position Assurance (CPA) lock (7) from the right side ignition coil main connector (6).
7. Connect the right side fuel injector wiring harness connectors (1) to the fuel injectors.



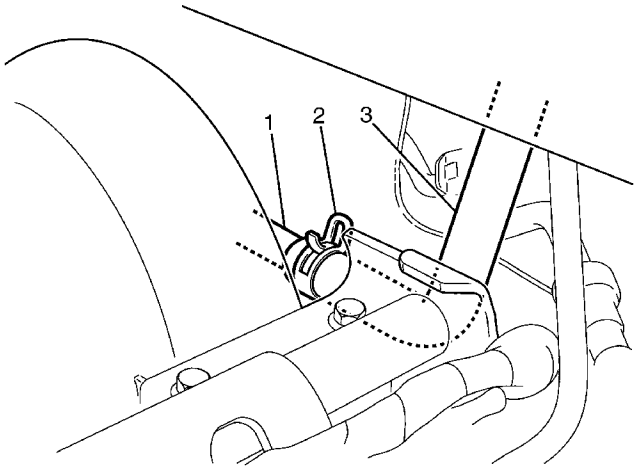
8. Position the left side fuel injector wiring harness (5) back to its original location the intake manifold (1).
9. Connect the left side ignition coil main connector (3) ignition coil wiring harness.
10. Install the CPA lock (4) from the left side ignition coil main connector (3).
11. Connect the left side fuel injector wiring harness connectors (2) to the fuel injectors.



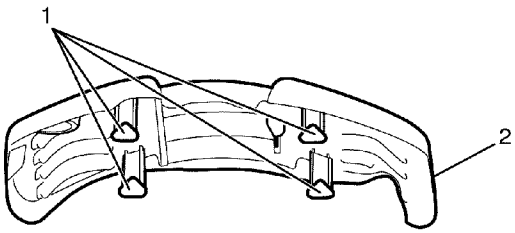
12. Connect the camshaft position sensor connector (4) to the camshaft sensor.
13. Connect the coolant temperature sensor connector (3) to the coolant sensor.
14. Attach the wiring harness retaining clip (2) to the engine lifting bracket (1).

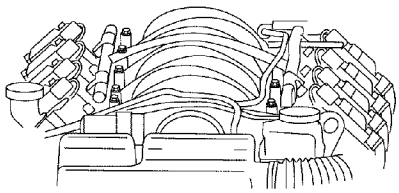


15. Connect the oil pressure sensor wiring harness connector (1) to the oil pressure sensor.
16. Connect the HVAC vacuum hose (2) to the intake manifold.

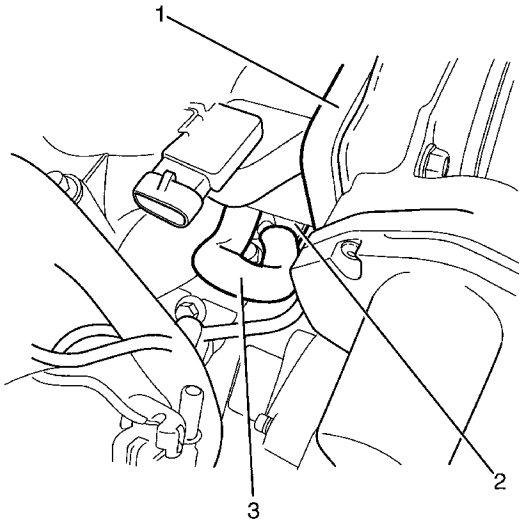


17. Compress the vacuum hose retaining clamp (2) at the intake manifold vacuum port (1) and slide 50 mm (2 in) back along the vacuum hose (3).
18. Connect the vacuum hose (3) to the intake manifold vacuum port (1).

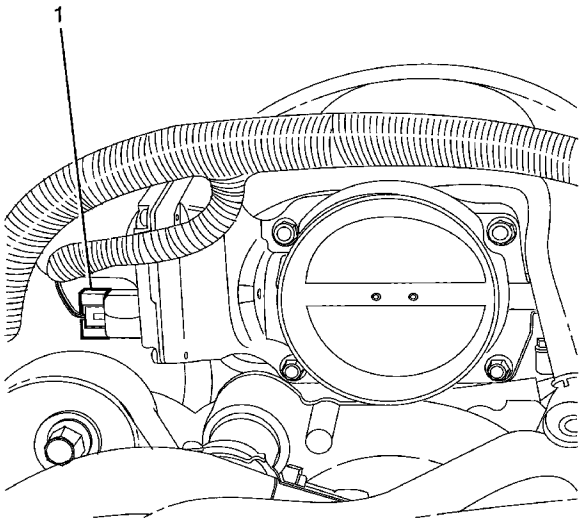




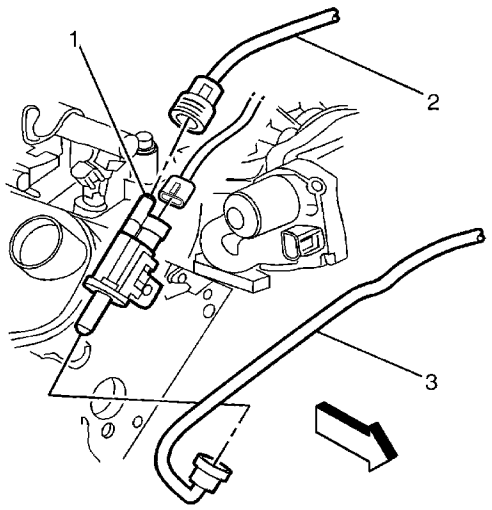
19. Connect the alternator wiring harness connector (1) to the alternator.



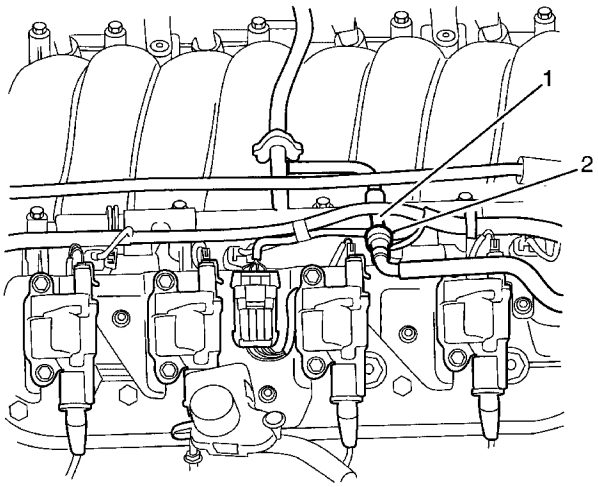
20. Connect the PCV hose (3) to the intake manifold (1) and the valley cover (2).



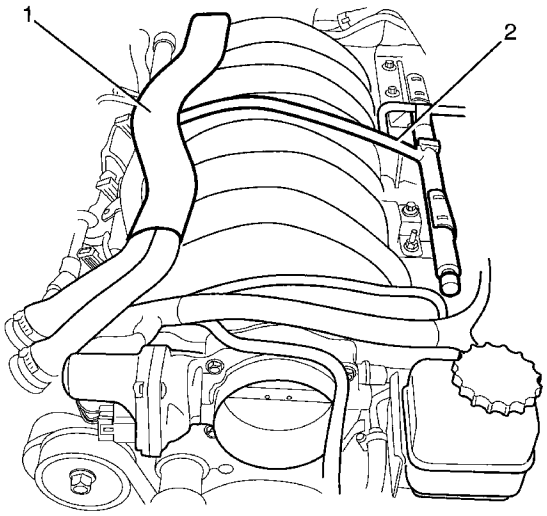
21. Connect the electronic throttle body wiring harness connector (1) to the throttle body.



22. Remove the plug on the throttle body to EVAP purge valve hose (3) and EVAP purge valve (1) ends.
23. Connect the throttle body to EVAP purge valve hose (3) to the EVAP purge valve (1).
24. Remove the plug on the throttle body to the EVAP purge valve to fuel tank hose (2) and EVAP purge valve (1) ends.
25. Connect the EVAP purge valve to fuel tank hose (2) to the EVAP purge valve (1).



26. Remove the plug on the fuel feed pipe (2) and fuel rail tube (1) end.
27. Connect the fuel rail feed pipe (2) quick connect fitting. Refer to Metal Collar Quick Connect Fitting Service or Plastic Collar Quick Connect Fitting Service.



28. Position the heater hoses (1) correctly on the intake manifold (2).
29. Install the air intake duct. Refer to Air Cleaner Inlet Duct Replacement.
30. Fill the cooling system. Refer to Cooling System Draining and Filling.
31. Connect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.
32. Run engine and check for leaks.
33. Install the engine cover. Refer to Engine Cover Replacement.

Valve Lifter Oil Manifold Replacement

Removal Procedure

1. Remove the intake manifold. Refer to Intake Manifold Replacement.
2. Remove the oil pressure sensor. Refer to Engine Oil Pressure Sensor and/or Switch Replacement.
3. Remove the VLOM. Refer to Valve Lifter Oil Manifold Removal.

Installation Procedure

1. Install the VLOM. Refer to Valve Lifter Oil Manifold Removal.
2. Install the oil pressure sensor. Refer to Engine Oil Pressure Sensor and/or Switch Replacement.
3. Install the intake manifold. Refer to Intake Manifold Replacement.

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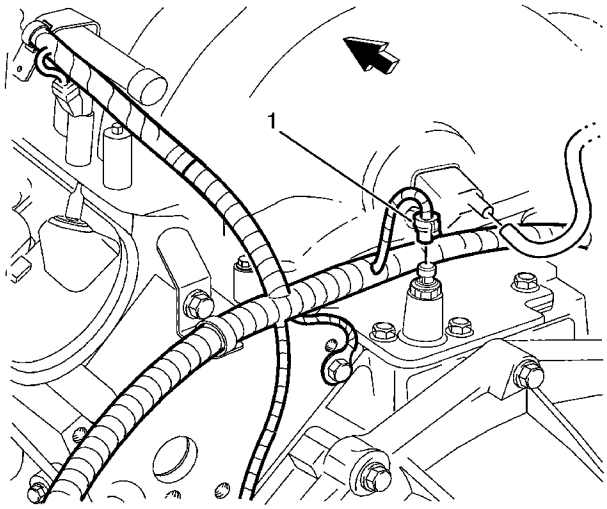
Valve Lifter Oil Filter Replacement

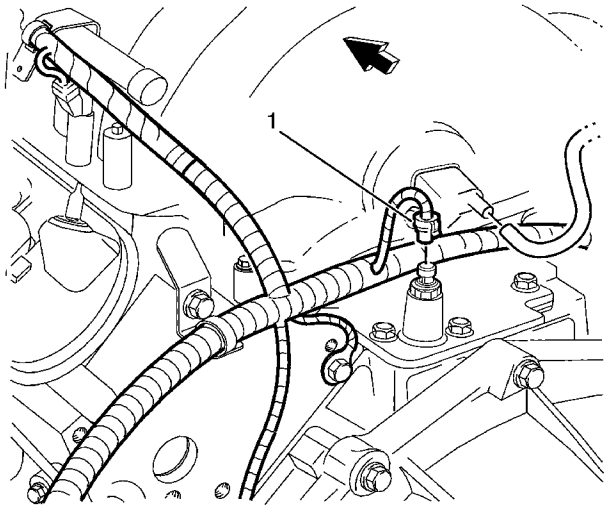
Removal Procedure



1. Disconnect the oil pressure sensor wiring harness connector (1).
2. Remove the valve lifter oil filter. Refer to Valve Lifter Oil Filter Removal.

Installation Procedure

1. Install the valve lifter oil filter. Refer to Valve Lifter Oil Filter Installation.



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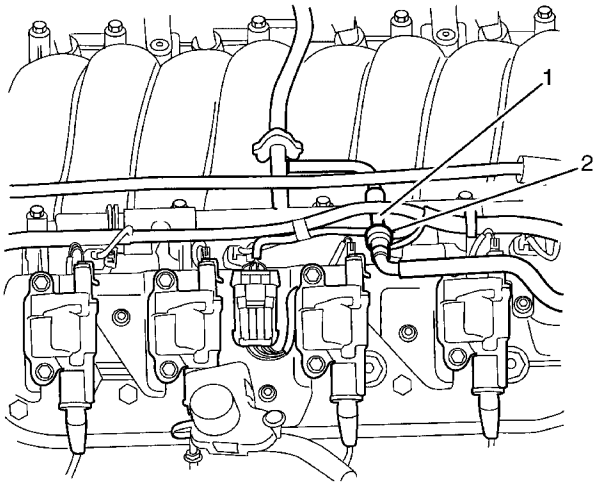
2. Connect the oil pressure sensor electrical connector (1).

Valve Rocker Arm Cover Replacement - Left Side

Removal Procedure

1. Remove the dress engine cover. Refer to Engine Cover Replacement.
2. Depressurize the fuel system. Refer to Fuel Pressure Relief.
3. Disconnect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.



Note: Plug or cap the fuel feed pipe (2) and fuel rail tube (1) ends to prevent fuel leaks and/or contamination.

4. Disconnect the fuel rail feed pipe (2) quick connect fitting. Refer to Metal Collar Quick Connect Fitting Service or Plastic Collar Quick Connect Fitting Service.

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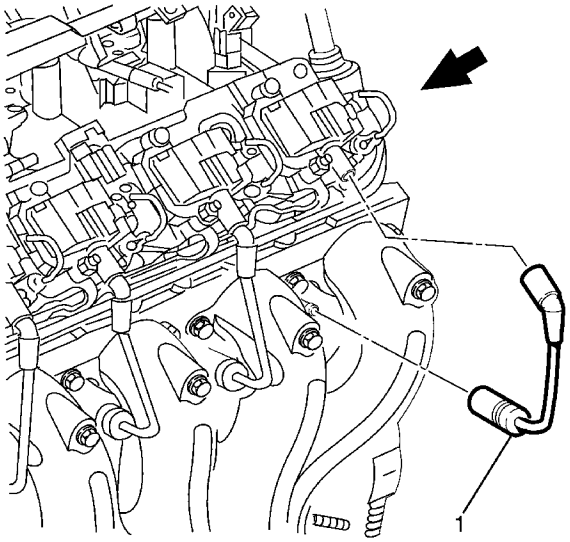
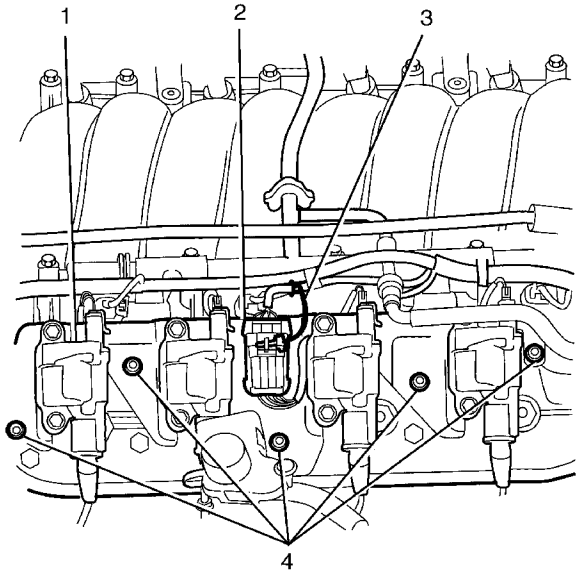
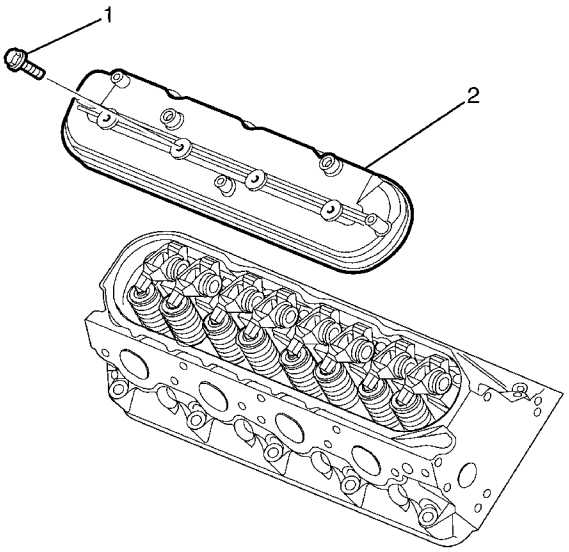


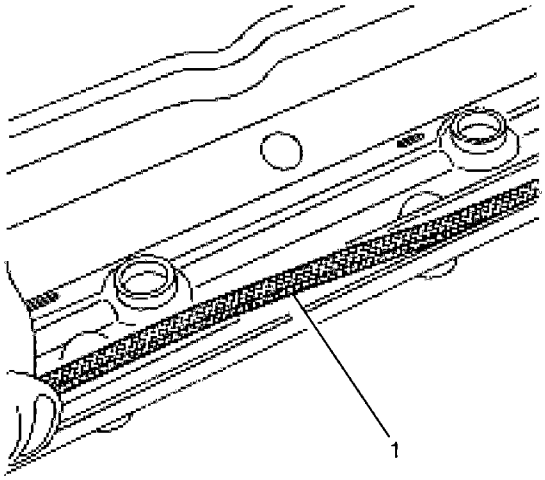
5. Remove the spark plug leads (1).



6. Remove the connector position assurance (CPA) lock (3) from the ignition coil main connector (2).
7. Disconnect the ignition coil main connector (2).
8. Remove the ignition coil assembly to valve rocker arm cover retaining studs (4).
9. Remove the ignition coil assembly (1).



10. Loosen the valve rocker arm cover to cylinder head retaining bolts (1).
11. Remove the valve rocker arm cover (2).



Note: The valve rocker arm cover gasket is a single use only component and must be replaced whenever the valve rocker arm cover is removed from the cylinder head.

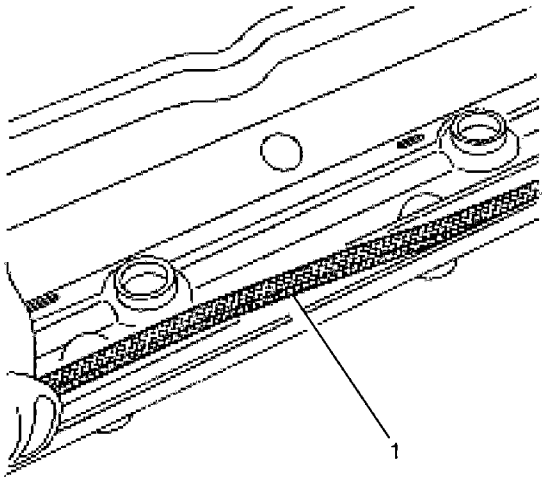
12. Remove the valve rocker arm cover gasket (1).

    Discard the valve rocker arm cover gasket (1).

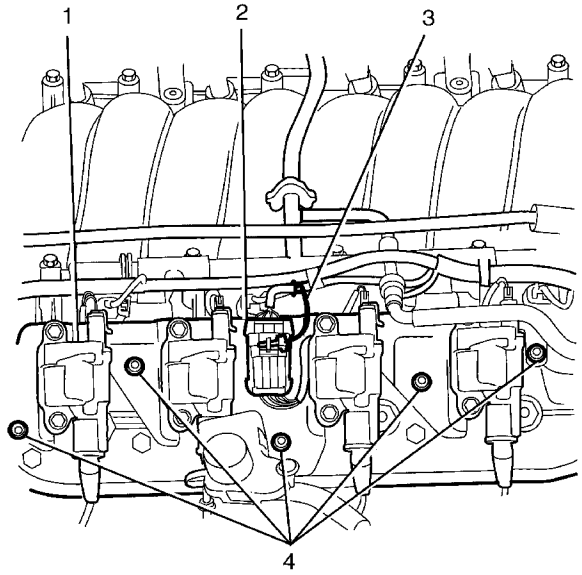
Installation Procedure

Note:

- All gasket surfaces should be free of oil and other foreign material during assembly.
- DO NOT reuse the valve rocker arm cover gasket.
- The valve rocker arm cover bolt grommets may be reused.
- If the positive crankcase ventilation (PCV) valve grommet has been removed from the rocker arm cover, install a NEW grommet during assembly.



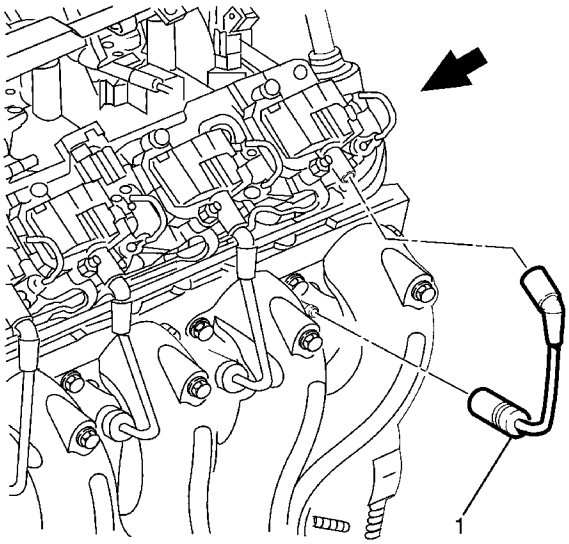
1. Install a NEW valve rocker arm cover gasket (1).
2. Install the valve rocker arm cover. Refer to Valve Rocker Arm Cover Installation - Left Side.



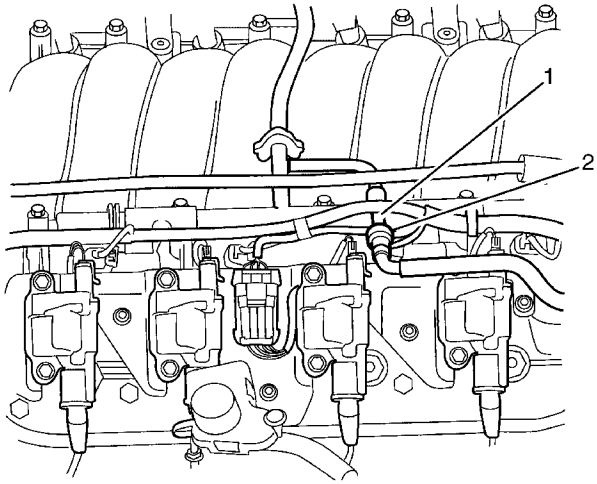
3. Install the ignition coil assembly (1).

Caution: Refer to Fastener Caution in the Preface section.

4. Install the ignition coil bracket to valve rocker arm cover retaining studs (4) and tighten to **12 N·m (106 lb in)**.
5. Connect the ignition coil main connector (2).
6. Install the CPA lock (3) from the ignition coil main connector (2).



7. Install the spark plug leads (1).

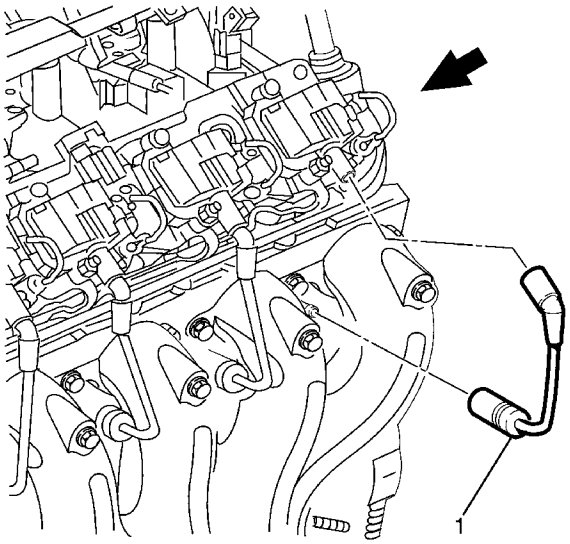


8. Remove the plug on the fuel feed pipe (2) and fuel rail tube (1) ends.
9. Connect the fuel rail feed pipe (2) quick connect fitting. Refer to Metal Collar Quick Connect Fitting Service or Plastic Collar Quick Connect Fitting Service.
10. Connect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.
11. Install the dress engine cover. Refer to Engine Cover Replacement.

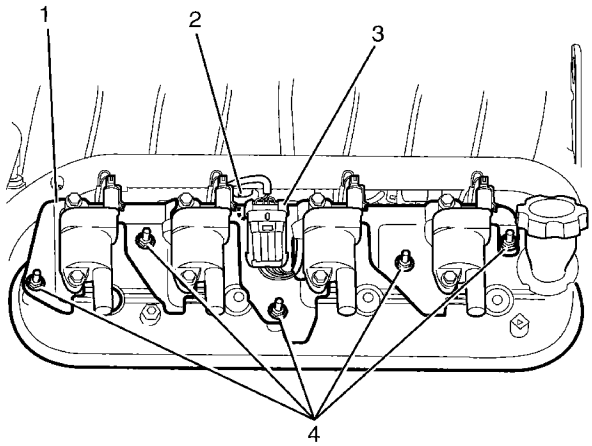
Valve Rocker Arm Cover Replacement - Right Side

Removal Procedure

1. Disconnect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.
2. Remove the engine cover. Refer to Engine Cover Replacement.



3. Remove the spark plug leads (1).



4. Remove the CPA lock (2) from the ignition coil main connector (3).

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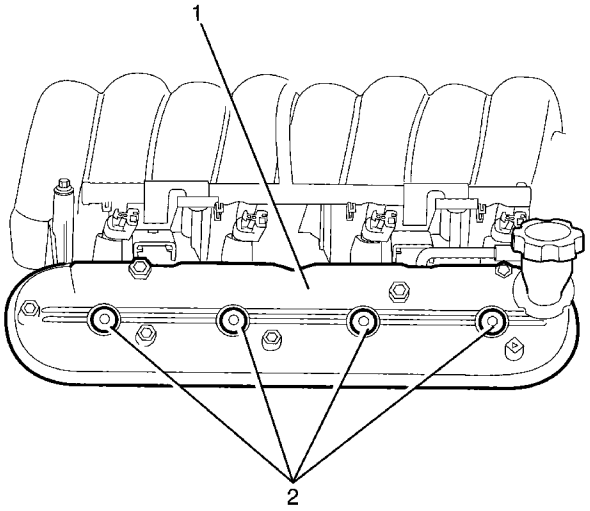
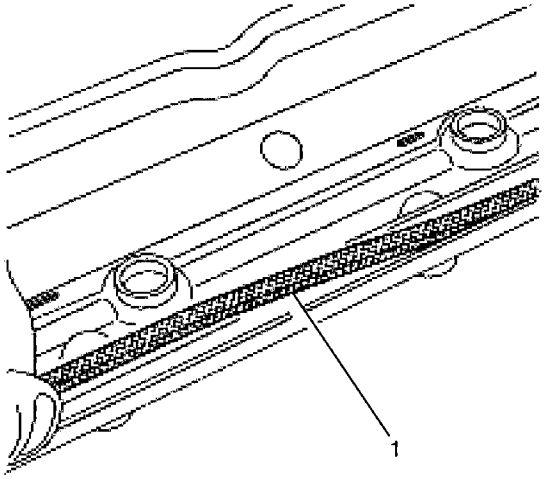
5. Disconnect the ignition coil main connector (3).
6. Remove the ignition coil assembly to valve rocker arm cover retaining studs (4).
7. Remove the ignition coil assembly (1).



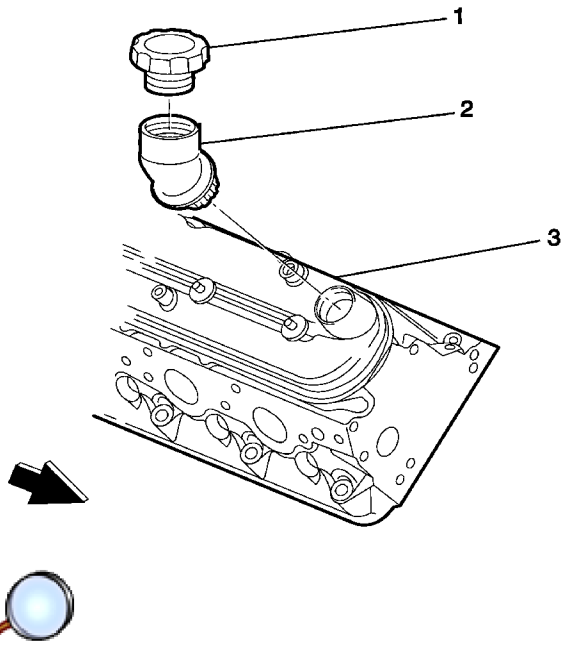
8. Remove the valve rocker arm cover retaining bolts (2) and valve rocker arm cover (1).
9. Remove the valve rocker arm cover (1). Refer to Valve Rocker Arm Cover Installation - Right Side.



Note: The valve rocker arm cover gasket is a single use only component and must be replaced whenever the valve rocker arm cover is removed from the cylinder head.

10. Remove the valve rocker arm cover gasket (1).

    Discard the valve rocker arm cover gasket (1).



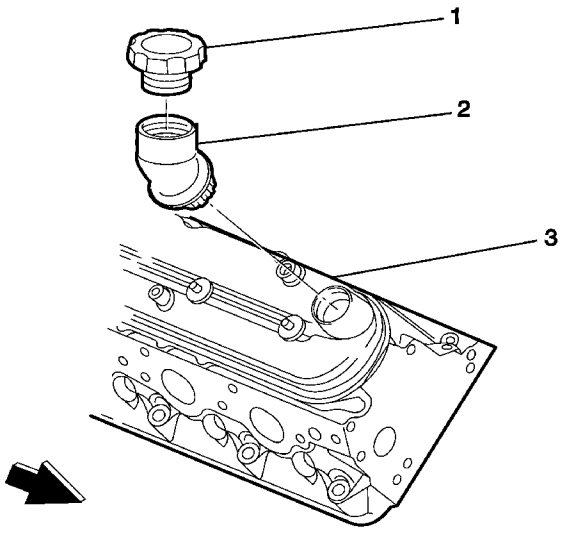
11. Remove the oil fill cap (1) from the oil fill tube (2).

    Note: Do not remove the oil fill tube from the cover, unless service is required. If the oil fill tube has been removed from the cover, install a NEW tube during assembly.

12. Remove the oil fill tube (2), from the right hand valve rocker arm cover (3) if required.

    Discard the oil fill tube (2).

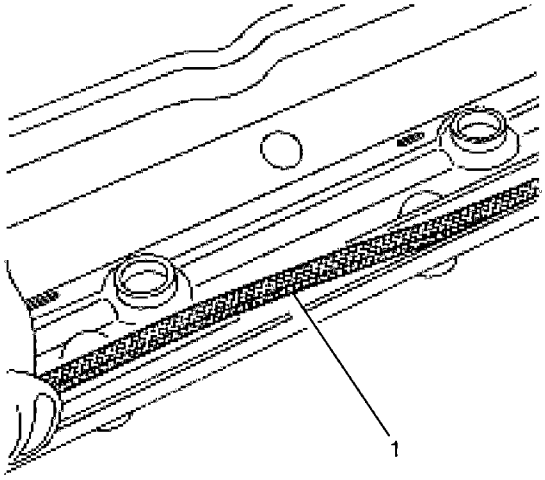
Installation Procedure



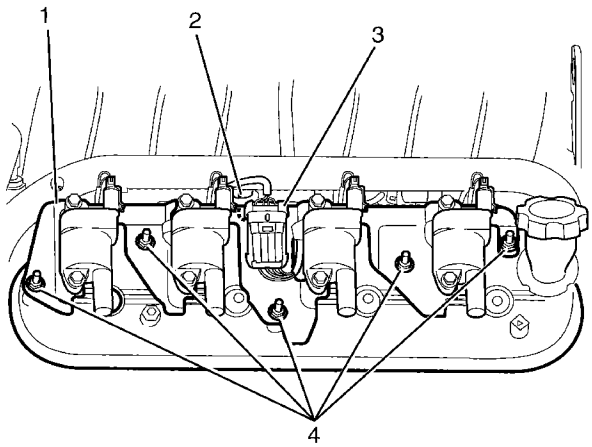
1. Install the NEW oil fill tube (2), to the right hand valve rocker arm cover (3) if required.
2. Install the oil fill cap (1) to the oil fill tube (2).

Note:

- All gasket surfaces should be free of oil and other foreign material during assembly.
- DO NOT reuse the valve rocker arm cover gasket.
- The valve rocker arm cover bolt grommets may be reused.



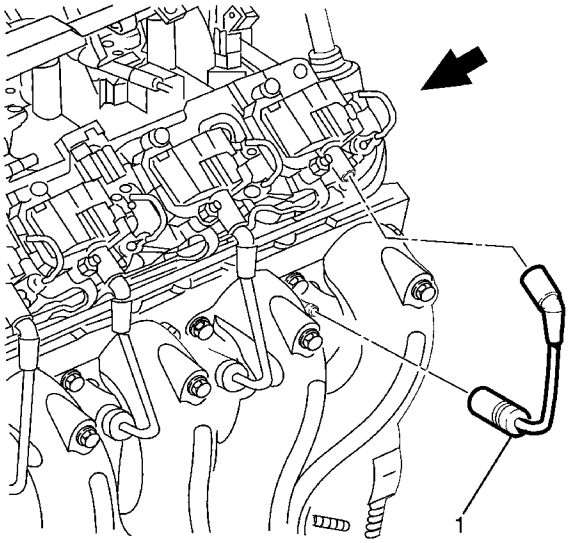
3. Install a NEW valve rocker arm cover gasket (1).
4. Install the valve rocker arm cover. Refer to Valve Rocker Arm Cover Installation - Right Side.



5. Install the ignition coil assembly (1).

Caution: Refer to Fastener Caution in the Preface section.

6. Install the ignition coil bracket to valve rocker arm cover retaining studs (4) and tighten to **12 N·m (106 lb in)**.
7. Connect the ignition coil main connector (3).
8. Install the CPA lock (2) from the ignition coil main connector (3).



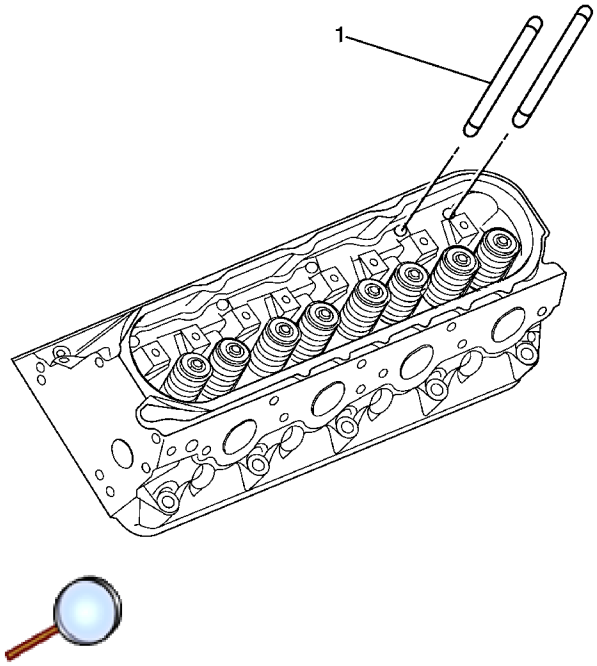
9. Install the spark plug leads (1).
10. Install the engine cover. Refer to Engine Cover Replacement.

Valve Rocker Arm and Push Rod Replacement

Removal Procedure

1. Remove the valve rocker arm covers. Refer to Valve Rocker Arm Cover Replacement - Left Side or Valve Rocker Arm Cover Replacement - Right Side.
2. Remove the valve rocker arm and push rods. Refer to Valve Rocker Arm and Push Rod Removal.
3. Clean and inspect the valve rocker arms and pushrods. Refer to Valve Rocker Arm and Push Rod Cleaning and Inspection.

Installation Procedure



Note:

- When using the valve train components again, always install the components to the original location and position.
- Valve lash is net build, no valve adjustment is required.

1. Lubricate the pushrods (1) with clean engine oil.

   Note: Make sure the pushrods (1) seat correctly to the valve lifter sockets.

2. Install the pushrods (1).

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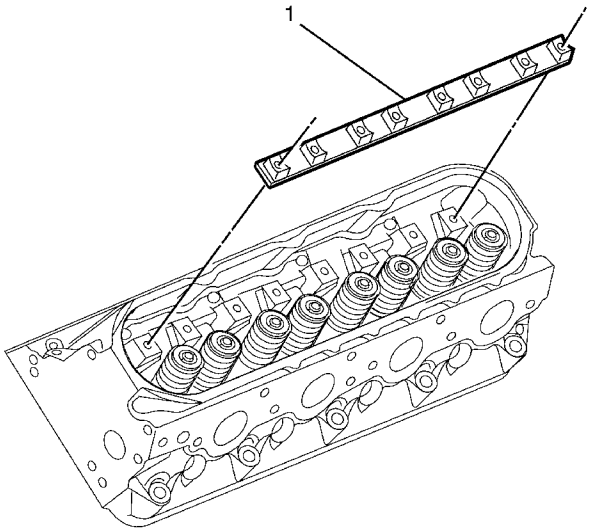
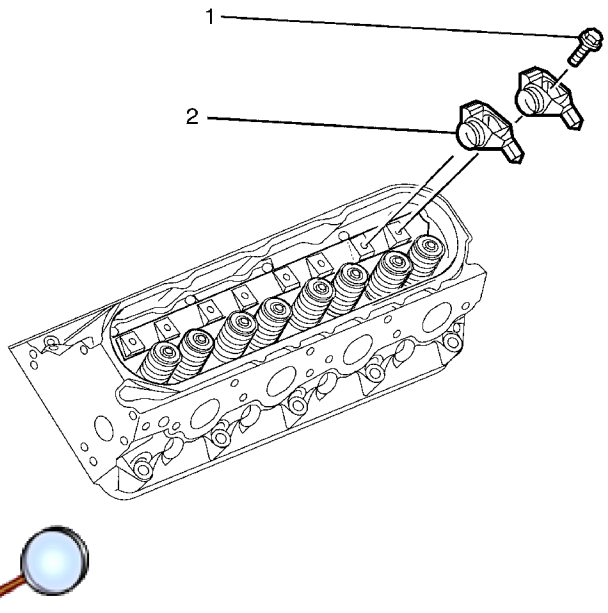


3. Install the valve rocker arm pivot support (1).

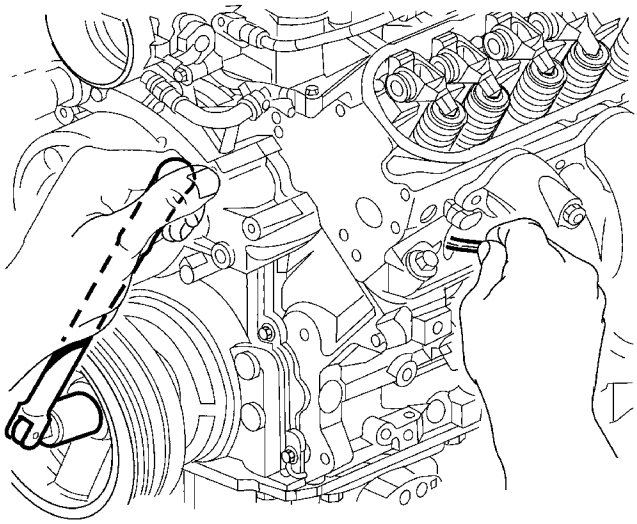


4. Lubricate the valve rocker arms (2) and pushrods with clean engine oil.
5. Lubricate the flange of the valve rocker arm bolts (1) with clean engine oil.

Note:

- Make sure the pushrods seat correctly to the ends of the rocker arms.
- DO NOT tighten the rocker arm bolts at this time.

6. Install the rocker arms and rocker arm retaining bolts.



Note: The Number 1 piston is at the compression stroke when the Number 6 cylinder inlet and exhaust valves are rocking, that is when the exhaust valve is at the end of its upward travel while the intake valve starts its downward movement.

Note: The engine firing order is 1-8-7-2-6-5-4-3. Cylinder numbers are 1-3-5-7 are on the left bank and 2-4-6-8 are on the right bank.

7. Rotate the crankshaft until number one piston is at top dead centre of compression stroke.

   Caution: Refer to Fastener Caution in the Preface section.

8. With the engine in the number one firing position, tighten the following valve rocker arm retaining bolts. Tighten exhaust valve rocker arm retaining bolts 1, 2, 7, and 8 to **30 N·m (22 lb ft)**. Tighten intake valve rocker arm retaining bolts 1, 3, 4, and 5 to **30 N·m (22 lb ft)**.
9. Rotate the crankshaft 360 degrees.
10. Tighten the following valve rocker arm retaining bolts. Tighten exhaust valve rocker arm retaining bolts 3, 4, 5, and 6 to **30 N·m (22 lb ft)**. Tighten intake valve rocker arm retaining bolts 2, 6, 7, and 8 to **30 N·m (22 lb ft)**.
11. Install the valve rocker arm covers. Refer to Valve Rocker Arm Cover Replacement - Left Side or Valve Rocker Arm Cover Replacement - Right Side.

Valve Stem Oil Seal and Valve Spring Replacement

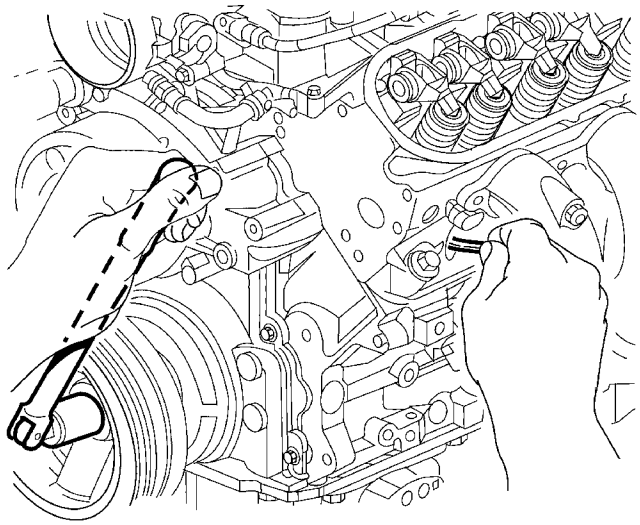
Tools Required

- J 22794 Spark Plug Port Adapter
- J 38606 Valve Spring Compressor (Head-on)

Removal Procedure

Important: Store all valve train components in the same order they are removed. Make sure all valve train components are installed in the same location as on removal.

1. Remove the valve rocker arms. Refer to Valve Rocker Arm and Push Rod Cleaning and Inspection.
2. Remove the spark plug. Refer to Spark Plug Replacement.



Important: This operation can be performed with the cylinder at the bottom of its stroke, however with the piston at TDC the valve will not fall into the cylinder if the air supply is accidentally disconnected during the operation.

3. Using a socket and handle on the crankshaft pulley retaining bolt, rotate the crankshaft until the piston of the cylinder being serviced is at the Top Dead Centre (TDC) of the compression stroke.

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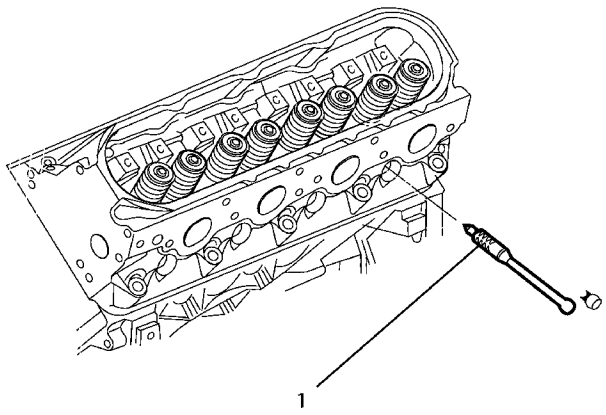
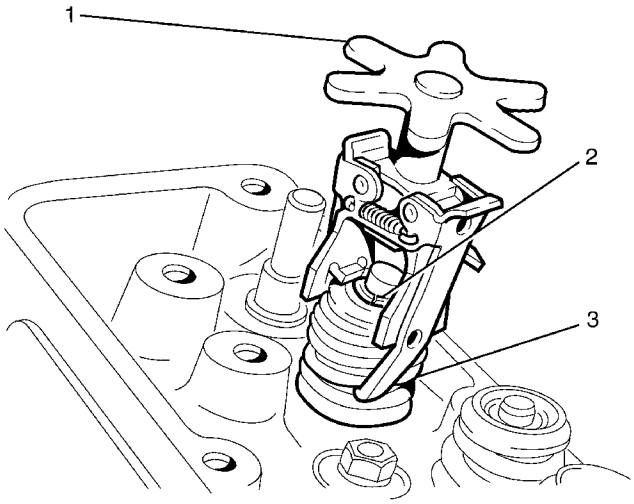
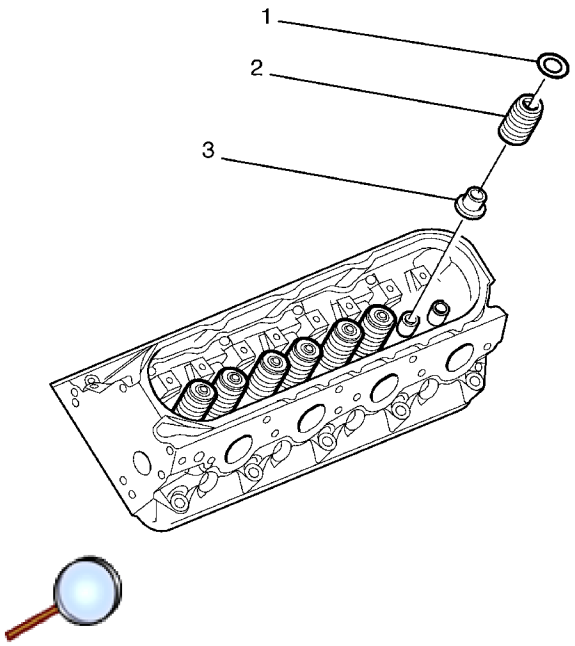


4. Install the J 22794 (1) or equivalent into the spark plug hole of the cylinder being serviced.
5. Attach a compressed air line to J 22794 (1) and apply a constant supply of air pressure to the cylinder being serviced.
6. Tap the end of the valve stem with a soft face hammer in order to dislodge the valve spring cap retaining collets.

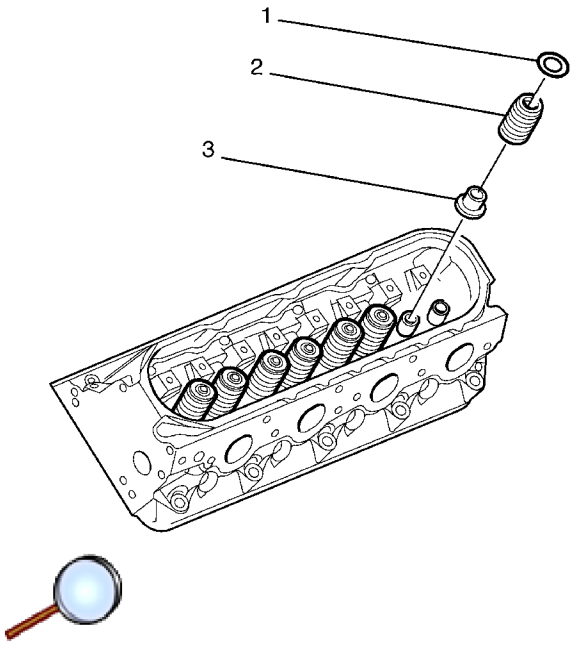


7. Use J 38606 (1) in order to compress the valve spring (3).
8. Remove the valve spring retaining cap collets (2).
9. Carefully release the valve spring (3) tension.
10. Remove the J 38606 (1).



11. Remove the valve spring cap (1).
12. Remove the valve spring (2).
13. Remove the valve stem oil seal (3).

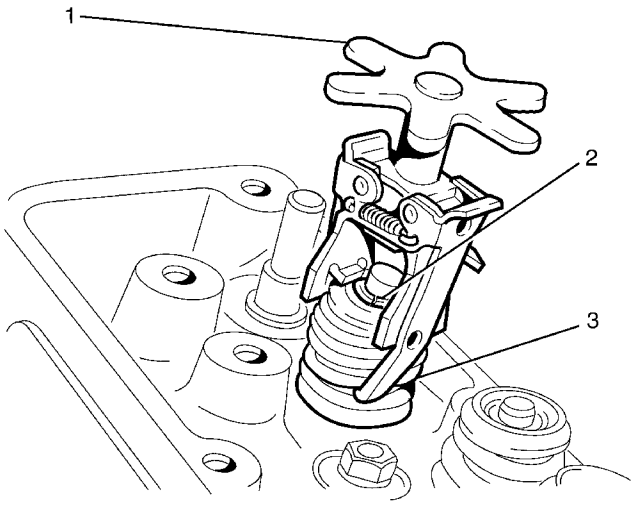
Installation Procedure



1. Clean the cylinder head valve spring seat and/or shim area.

Important: The valve stem oil seal alignment and position on the valve guide is critical. An incorrectly installed valve stem oil seal may lead to above acceptable oil consumption and increased vehicle emissions.

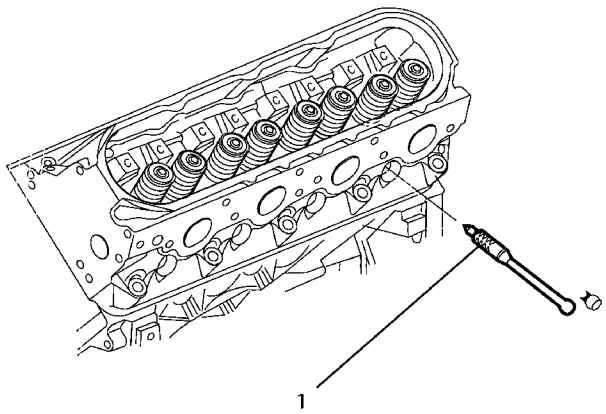
2. Install the valve stem oil seal (3). onto the guide.
3. Install the valve spring (2).
4. Install the valve spring cap (1).



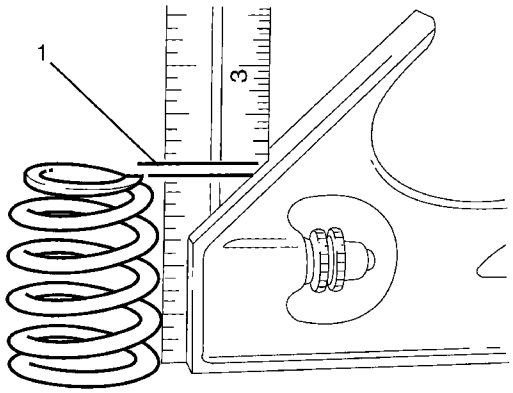
5. Use J 38606 (1) in order to compress the valve spring (3).
6. Compress the valve spring using the J 38606 (1).

Important: Use clean grease or petroleum jelly to retain the valve spring retaining collets (2)

7. Install the valve spring retaining collets (2).
8. Release the J 38606 (1) making sure both valve spring retaining collets have seated correctly.
9. Lightly tap the valve stem with a soft faced hammer to seat the valve stem collets.



10. Disconnect and remove the compressed air supply from the J 22794 (1).
11. Remove the J 22794 (1) from the spark plug hole.

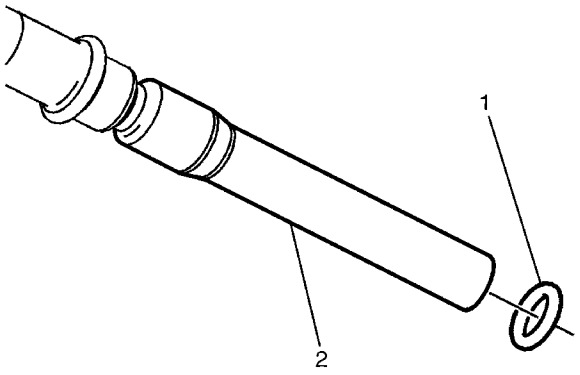


12. Measure the valve spring installed height using a ruler.

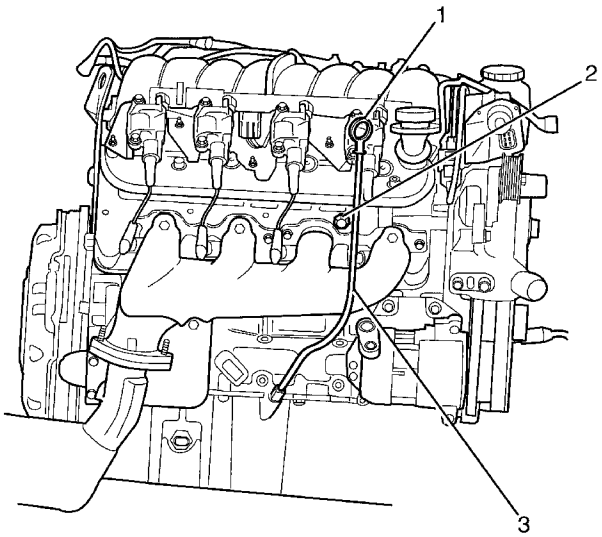
    Measure from the base of the valve spring to the top of the valve spring.

    - If the installed height exceeds 46.25 mm (1.82 in), install a valve spring shim of approximately 0.5 mm (0.02 in) thick.
    - Do not shim the valve spring to obtain less than the specified height.
    - Do not assemble the components without a spring shim on the cylinder head.
13. Install the spark plug. Refer to Spark Plug Replacement.
14. Install the valve rocker arms. Refer to Valve Rocker Arm and Push Rod Cleaning and Inspection.

Oil Level Indicator Tube Replacement



1. Inspect the O-ring seal (1) for cuts or damage. If the O-ring seal (1) is not cut or damaged, it may be used again.
2. Lubricate the O-ring seal (1) with clean engine oil.
3. Install the O-ring seal (1) onto the oil level indicator tube (2).



4. Install the oil level indicator tube (2) to the engine and rotate into correct position.

Caution: Refer to Fastener Caution in the Preface section.

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5. Install oil level indicator tube to cylinder head bracket retaining bolt (3) and tighten to **25 N·m (18 lb ft)**.
6. Install the oil level indicator (1) to the oil level indicator tube (2).

Cylinder Head Replacement - Left Side

Special Tools

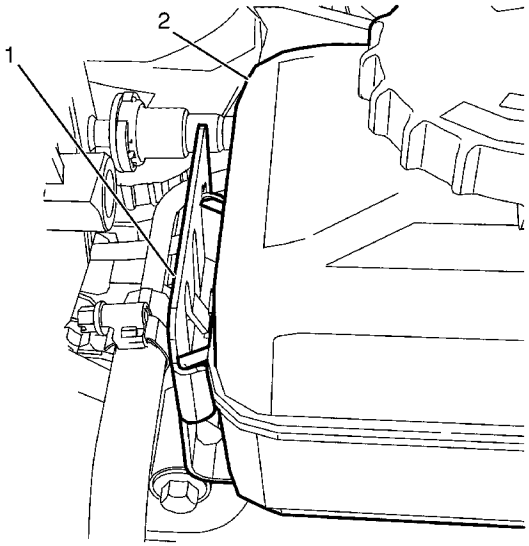
- J 42385-100 Head/Main Bolt Thread Repair Kit
- J 45059 Angle Meter

Removal Procedure

1. Remove the engine cover. Refer to Engine Cover Replacement.
2. Depressurize the fuel system. Refer to Fuel Pressure Relief.

Warning: Refer to Battery Disconnect Warning in the Preface section.

3. Disconnect the battery ground cable from the battery. Refer to Battery Negative Cable Disconnection and Connection.
4. Drain the cooling system. Refer to Cooling System Draining and Filling.
5. Remove the intake manifold assembly. Refer to Intake Manifold Replacement.
6. Remove the engine coolant air bleed pipe and cover. Refer to Engine Coolant Air Bleed Hose Replacement.
7. Remove the accessory drive belt. Refer to Drive Belt Replacement - Accessory.
8. Remove the left side ignition coils. Refer to Ignition Coil Replacement.
9. Remove the spark plugs. Refer to Spark Plug Replacement.
10. Remove the left side exhaust manifold. Refer to Exhaust Manifold Replacement - Left Side.



Note: The locking tang on the power steering reservoir bracket (1) must be released before removing the power steering reservoir (2).

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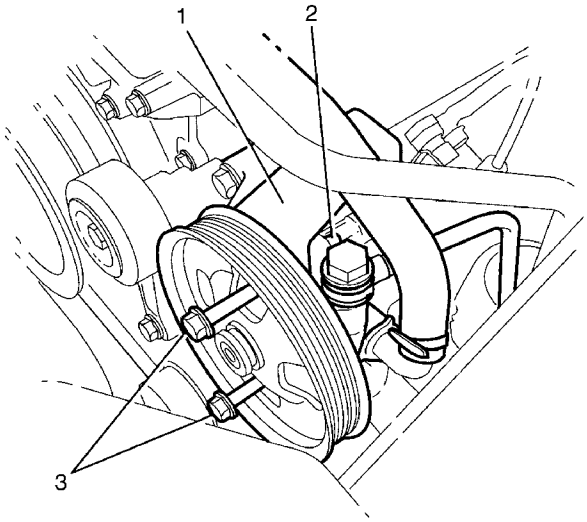
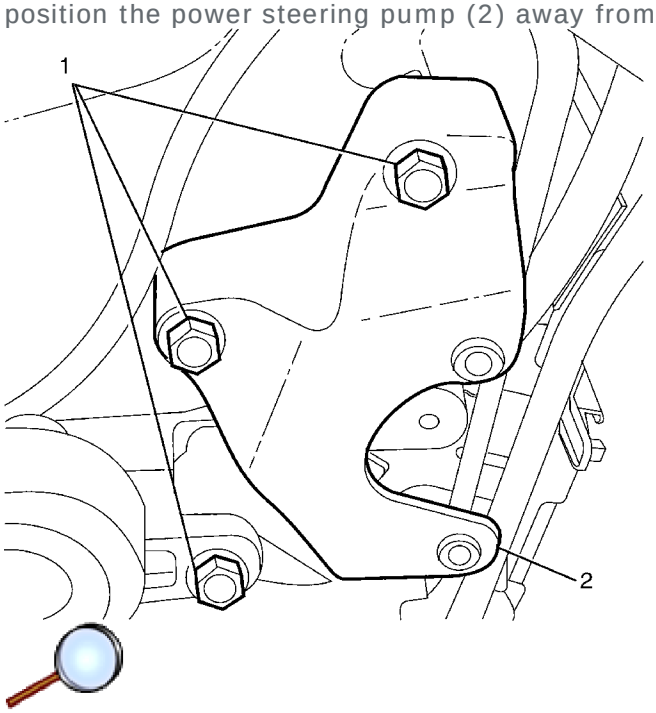
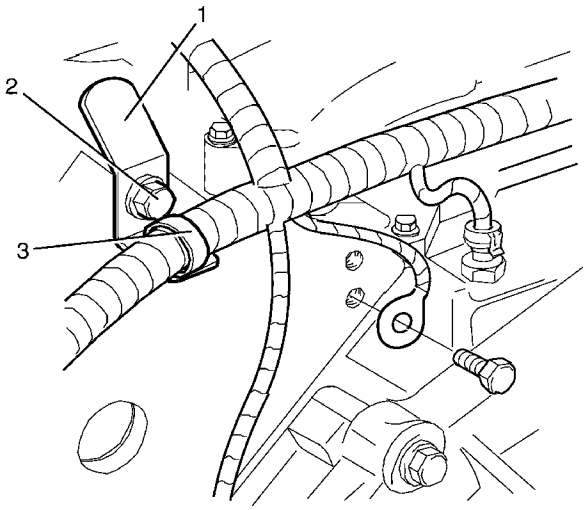
11. Remove the power steering reservoir (2) from the power steering pump power steering reservoir bracket (1) and position the power steering reservoir (2) aside.



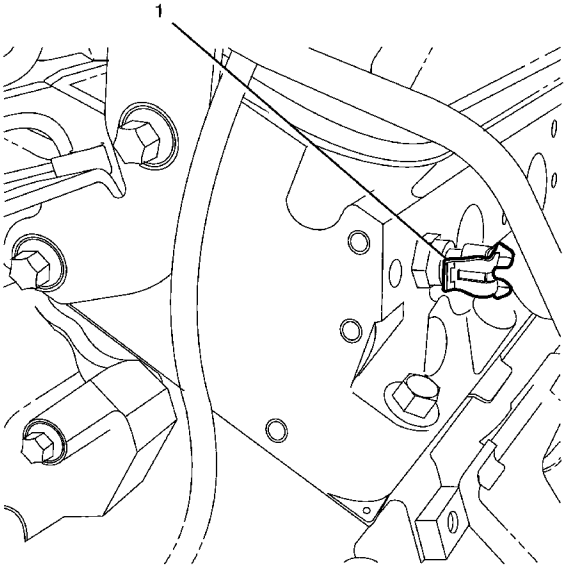
12. Remove the power steering pump (2) to power steering pump bracket retaining bolts (3) and position the power steering pump (2) away from the power steering pump bracket (1).



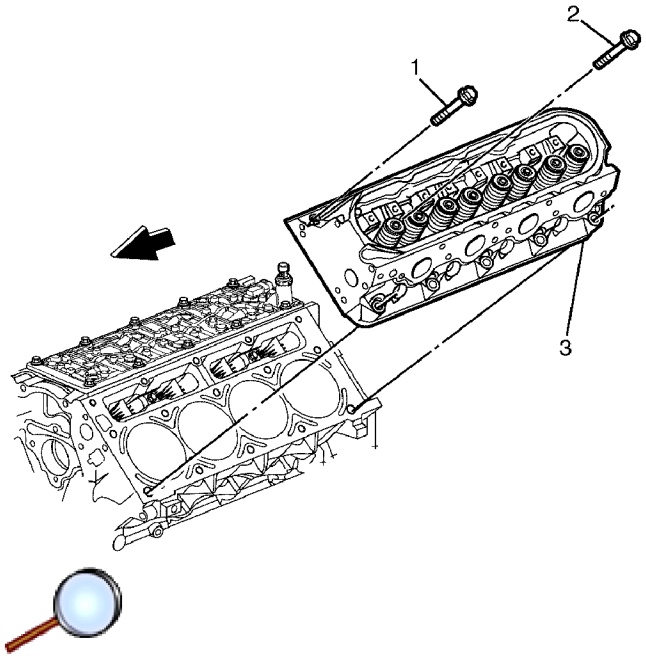
13. Remove the power steering pump bracket to engine retaining bolts (1).
14. Remove the power steering pump bracket (2).



15. Detach the powertrain wiring harness strap (3) from the rear cylinder head bracket (1).
16. Remove the powertrain wiring harness ground cable to cylinder head retaining bolt (2).



17. Disconnect the coolant temperature sensor electrical connector (1).
18. Remove the left side valve rocker arm cover. Refer to Valve Rocker Arm Cover Replacement - Left Side.
19. Remove the left side valve rocker arms and pushrods. Refer to Valve Rocker Arm and Push Rod Replacement.



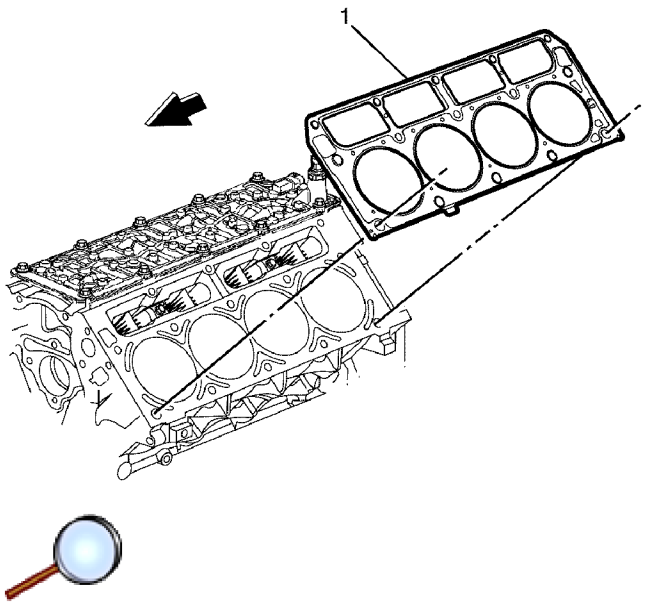
Note: The cylinder head bolts are torque to yield bolts and are single use only fasteners.

20. Remove and discard the cylinder head bolts (1) 10 places, (2) 5 places.

    Discard the bolts.

    Note: After removal, place the cylinder head on 2 wooden blocks in order to prevent damage to the sealing surfaces.

21. Remove the cylinder head (3).



Note: Cylinder head gaskets must be discarded whenever the cylinder head has been

removed from the cylinder block.

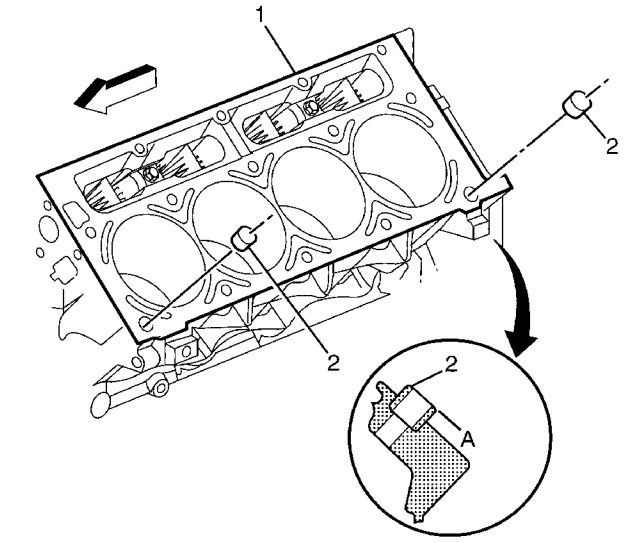
22. Remove the cylinder head gasket (1).

    Discard the gasket.

23. Clean and inspect the cylinder head and the cylinder block sealing surfaces. Refer to Cylinder Head Cleaning and Inspection and Engine Block Cleaning and Inspection.
24. If necessary, disassemble the cylinder head. Refer to Cylinder Head Disassemble.

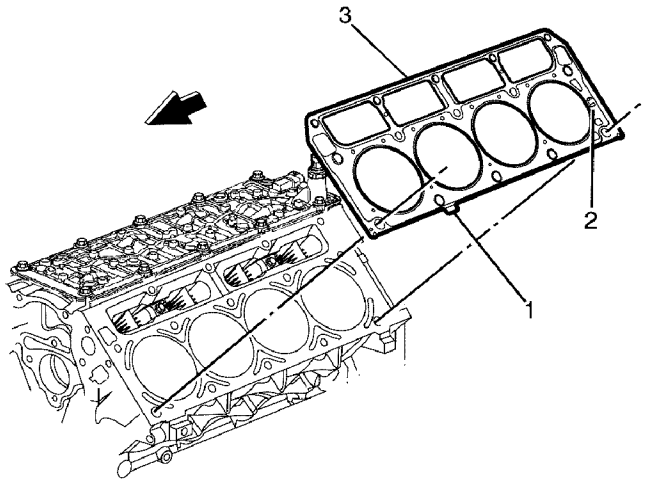
Installation Procedure

1. If necessary, assemble the cylinder head. Refer to Cylinder Head Assemble.



Note: Make sure the locating sleeves (2) are correctly installed to the maximum height (A) of 8.3 mm (0.33 in).

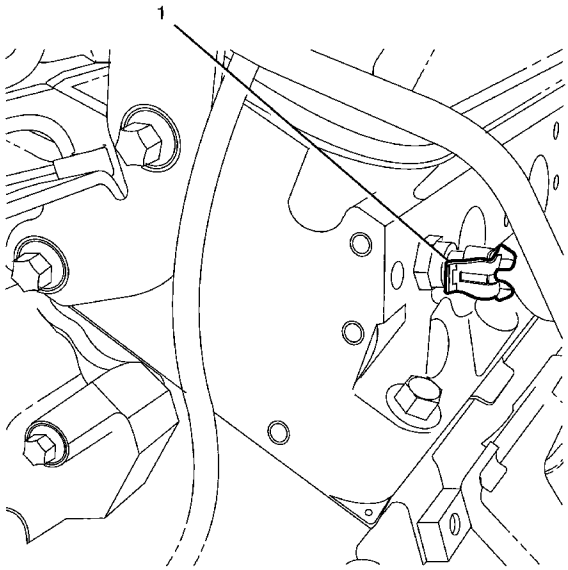
2. Install the locating sleeves (2) into the cylinder block (1).



Note: The cylinder head gasket (3) will fit on either side of the engine. Make sure the tab on the cylinder head gasket (1) is located towards the front half point and the stamping FRONT on the cylinder head gasket (2) is facing the front of the engine.

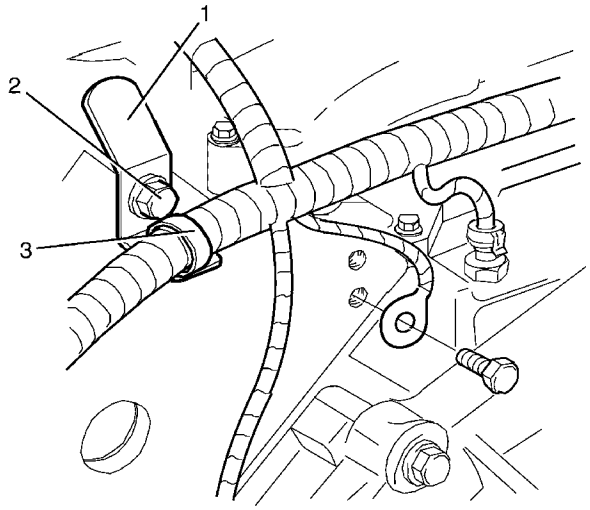
Note: Do not use any type of sealant on the cylinder head gasket (3), unless specified.

3. Install the NEW cylinder head gasket (3) correctly over the locating sleeves.
4. Install the cylinder head with the exhaust manifold to the engine. Refer to Cylinder Head Installation - Left Side.
5. Install the left side valve rocker arms and pushrods. Refer to Valve Rocker Arm and Push Rod Replacement.
6. Install the left side valve rocker arm cover. Refer to Valve Rocker Arm Cover Replacement - Left Side.

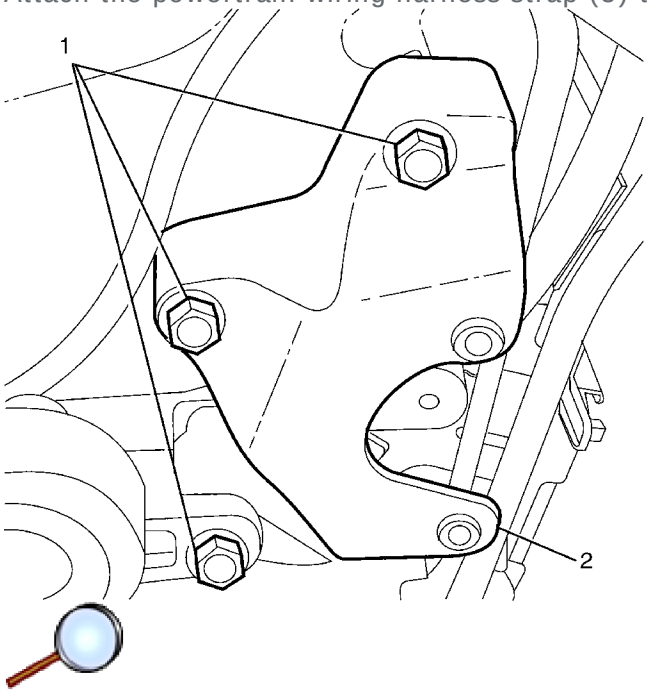


7. Connect the coolant temperature sensor electrical connector (1).

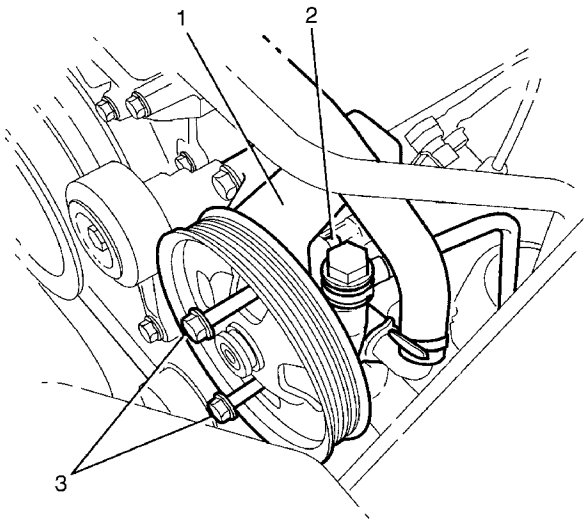
Caution: Refer to Fastener Caution in the Preface section.



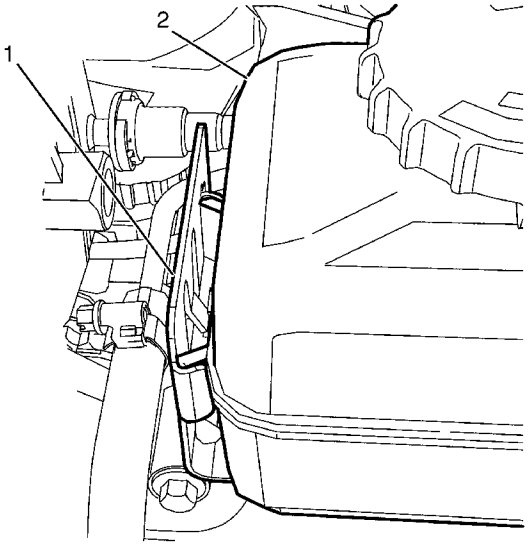
8. Install the engine wiring harness ground connector to cylinder head retaining bolt (2) and tighten to **10 N·m (89 lb in)**.
9. Attach the powertrain wiring harness strap (3) to the rear cylinder head bracket (1).



10. Install the power steering pump bracket (2).
11. Install the power steering pump bracket to engine retaining bolts (1) and tighten to **58 N·m (43 lb ft)**.



12. Position the power steering pump (2) on the power steering pump bracket (1).
13. Install the power steering pump to power steering pump bracket retaining bolts (3) and tighten to **30 N·m (22 lb ft)**.



Note: Make sure the power steering reservoir (2) and the locking tang on the power steering reservoir bracket (1) are engaged to avoid an induced rattle condition.

14. Install the power steering reservoir (2) to the power steering pump power steering reservoir bracket (1).
15. Install the left side exhaust manifold. Refer to Exhaust Manifold Replacement - Left Side.
16. Install the spark plugs. Refer to Spark Plug Replacement.
17. Install the left side ignition coils. Refer to Ignition Coil Replacement.
18. Install the accessory drive belt. Refer to Drive Belt Replacement - Accessory.

19. Install the engine coolant air bleed pipe and cover. Refer to Engine Coolant Air Bleed Hose Replacement.
20. Install the intake manifold assembly. Refer to Intake Manifold Replacement.
21. Refill the cooling system. Refer to Cooling System Draining and Filling.
22. Connect the battery ground cable to the battery. Refer to Battery Negative Cable Disconnection and Connection.
23. Install the engine cover. Refer to Engine Cover Replacement.

Cylinder Head Replacement - Right Side

Special Tools

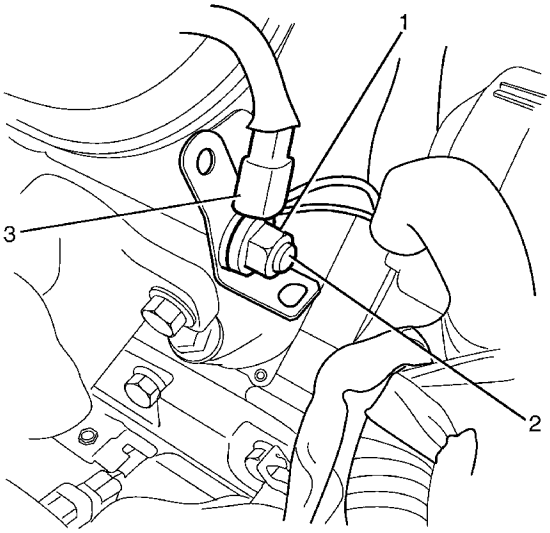
- J 42385-100 J-42385-100
- J 45059 J-45059

Removal Procedure

1. Remove the engine cover. Refer to Engine Cover Replacement.
2. Depressurize the fuel system. Refer to Fuel Pressure Relief.

Warning: Refer to Battery Disconnect Warning in the Preface section.

3. Disconnect the battery ground cable from the battery. Refer to Battery Negative Cable Disconnection and Connection.
4. Drain the cooling system. Refer to Cooling System Draining and Filling.
5. Remove the intake manifold assembly. Refer to Intake Manifold Replacement.
6. Remove the engine coolant air bleed pipe and cover. Refer to Engine Coolant Air Bleed Hose Replacement.
7. Remove the right side ignition coils. Refer to Ignition Coil Replacement.
8. Remove the spark plugs. Refer to Spark Plug Replacement.
9. Remove the oil level indicator and tube. Refer to Oil Level Indicator and Tube Replacement.



10. Remove the vehicle body ground cable to cylinder head retaining nut (1).
11. Remove the vehicle body ground cable (3) from the cylinder head stud (2).

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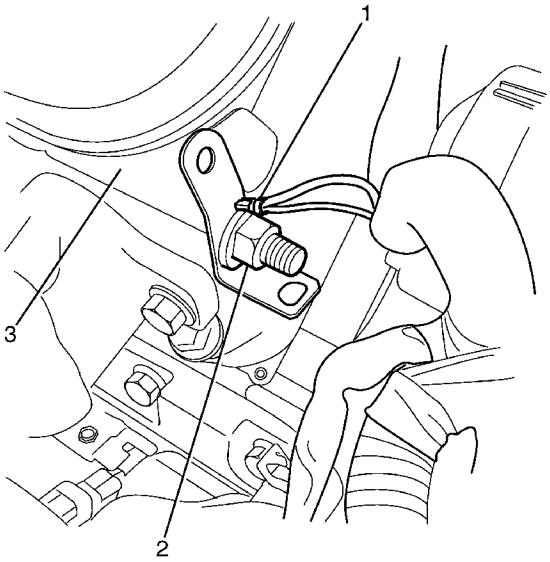
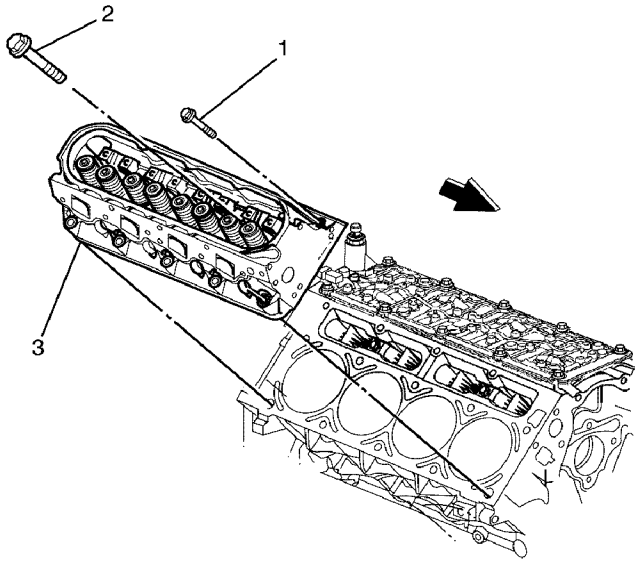


12. Remove the cylinder head stud (3) from the cylinder head (2) and secure the wiring harness ground (1) away from the cylinder head (2).
13. Remove the right side exhaust manifold. Refer to Exhaust Manifold Replacement - Right Side.
14. Remove the right side valve rocker arm cover. Refer to Valve Rocker Arm Cover Replacement - Right Side.
15. Remove the right side valve rocker arms and pushrods. Refer to Valve Rocker Arm and Push Rod Replacement.



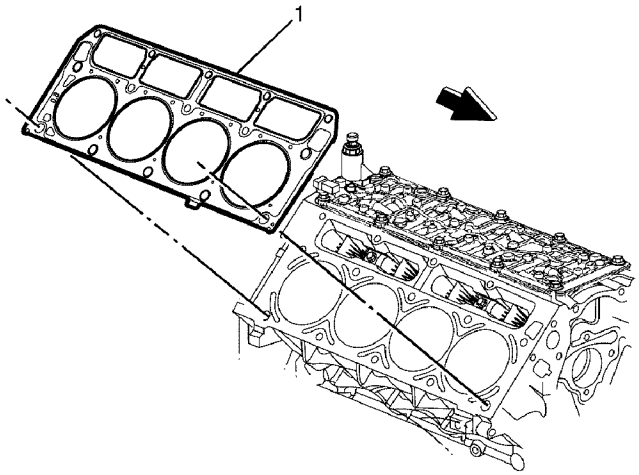
Note: The cylinder head bolts are torque to yield bolts and are single use only fasteners.

16. Remove and discard the cylinder head bolts (1) 10 places, (2) 5 places.

    Discard the bolts.

Note: After removal, place the cylinder head on 2 wooden blocks in order to prevent damage to the sealing surfaces.

17. Remove the cylinder head (3).



Note: Cylinder head gaskets must be discarded whenever the cylinder head has been removed from the cylinder block.

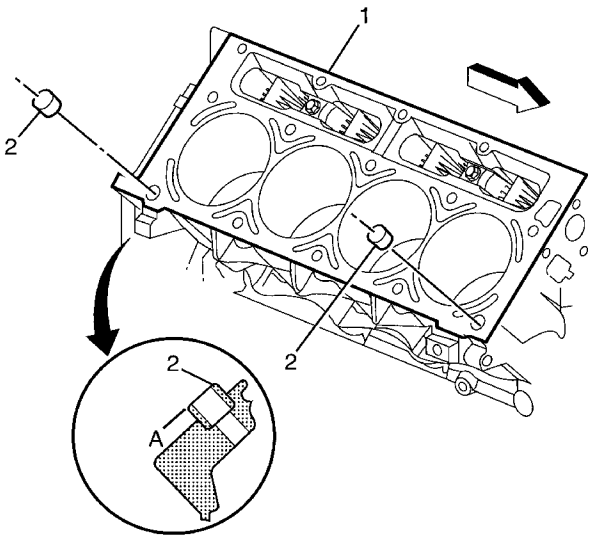
18. Remove the cylinder head gasket (1).

    Discard the gasket.

19. Clean and inspect the cylinder head and the cylinder block sealing surfaces. Refer to Cylinder Head Cleaning and Inspection and Engine Block Cleaning and Inspection.
20. If necessary, disassemble the cylinder head. Refer to Cylinder Head Disassemble.

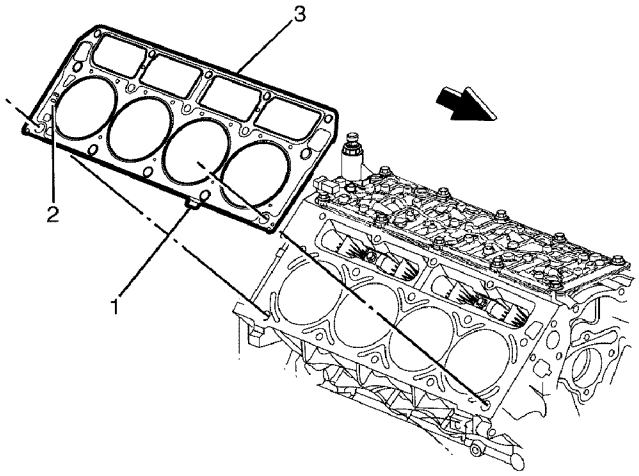
Installation Procedure

1. If necessary, assemble the cylinder head. Refer to Cylinder Head Assemble.



Note: Make sure the locating sleeves (2) are correctly installed to the maximum height (A) of 8.3 mm (0.33 in).

2. Install the locating sleeves (2) into the cylinder block (1).

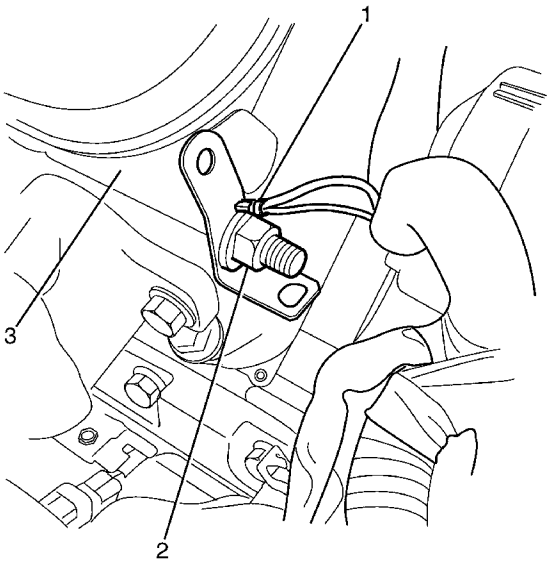


Note: The cylinder head gasket (3) will fit on either side of the engine. Make sure the tab on the cylinder head gasket (1) is located towards the front half point and the stamping FRONT on the cylinder head gasket (2) is facing the front of the engine.

Note: Do not use any type of sealant on the cylinder head gasket (1), unless specified.

3. Install the NEW cylinder head gasket (3) correctly over the locating sleeves.

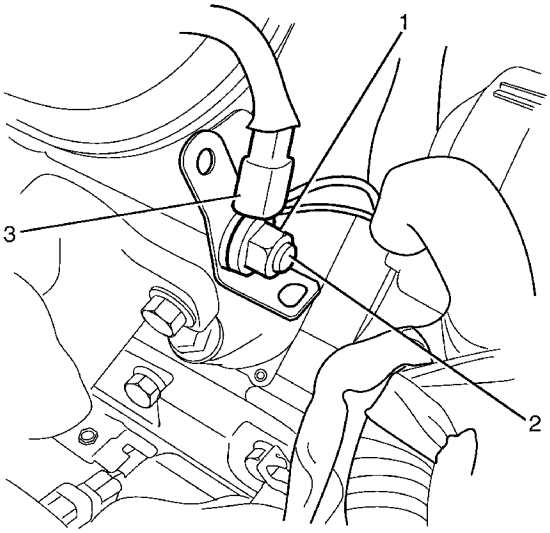
4. Install the cylinder head with the exhaust manifold to the engine. Refer to Ignition Coil Replacement.
5. Install the right side valve rocker arms and pushrods. Refer to Valve Rocker Arm and Push Rod Replacement.
6. Install the right side valve rocker arm cover. Refer to Valve Rocker Arm Cover Replacement - Right Side.
7. Install the right side exhaust manifold. Refer to Exhaust Manifold Replacement - Right Side.



8. Position the wiring harness ground (1) on the cylinder head (2).

Caution: Refer to Fastener Caution in the Preface section.

9. Install the cylinder head stud (3) to the cylinder head (2) and tighten to **30 N·m (22 lb ft)**.



10. Position the vehicle body ground cable (3) on the cylinder head stud (2).

11. Install the vehicle body ground cable to cylinder head retaining nut (1) and tighten to **12 N·m (106 lb ft)**.
12. Install the oil level indicator and tube. Refer to Oil Level Indicator and Tube Replacement.
13. Install the spark plugs. Refer to Spark Plug Replacement.
14. Install the right side ignition coils. Refer to Ignition Coil Replacement.
15. Install the engine coolant air bleed pipe and cover. Refer to Engine Coolant Air Bleed Hose Replacement.
16. Install the intake manifold assembly. Refer to Intake Manifold Replacement.
17. Refill the cooling system. Refer to Cooling System Draining and Filling.
18. Connect the battery ground cable to the battery. Refer to Battery Negative Cable Disconnection and Connection.
19. Install the engine cover. Refer to Engine Cover Replacement.

Valve Lifter Replacement

Removal Procedure

1. Remove the cylinder head. Refer to Cylinder Head Replacement - Left Side or Cylinder Head Replacement - Right Side .
2. Remove the valve lifters. Refer to Valve Lifter Removal .

Installation Procedure

1. Install the valve lifters. Refer to Valve Lifter Installation .
2. Install the cylinder head. Refer to Cylinder Head Installation - Left Side or Cylinder Head Installation - Right Side .

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Crankshaft Balancer Replacement

Tools Required

- J 41816-A Crankshaft Balancer Remover
- J 41816-2 Crankshaft End Protector
- J 42386-A Flywheel Holding Tool
- J 41665 Crankshaft Balancer and Sprocket Installer

Removal Procedure

1. Disconnect the battery. Refer to Battery Negative Cable Disconnection and Connection.
2. Remove the radiator. Refer to Radiator Replacement.
3. Remove the accessory drive belt. Refer to Drive Belt Replacement - Accessory.
4. Remove the air conditioning (A/C) drive belt. Refer to Air Conditioning Compressor Belt Replacement.
5. Remove the starter motor. Refer to Starter Motor Replacement.
6. Remove the crankshaft balancer. Refer to Crankshaft Balancer Removal.

Installation Procedure

1. Install the crankshaft balancer. Refer to Crankshaft Balancer Installation.
2. Install the starter motor. Refer to Starter Motor Replacement.
3. Install the air conditioning (A/C) drive belt. Refer to Air Conditioning Compressor Belt Replacement.
4. Install the accessory drive belt. Refer to Drive Belt Replacement - Accessory.
5. Install the radiator. Refer to Radiator Replacement.
6. Connect the battery. Refer to Battery Negative Cable Disconnection and Connection.

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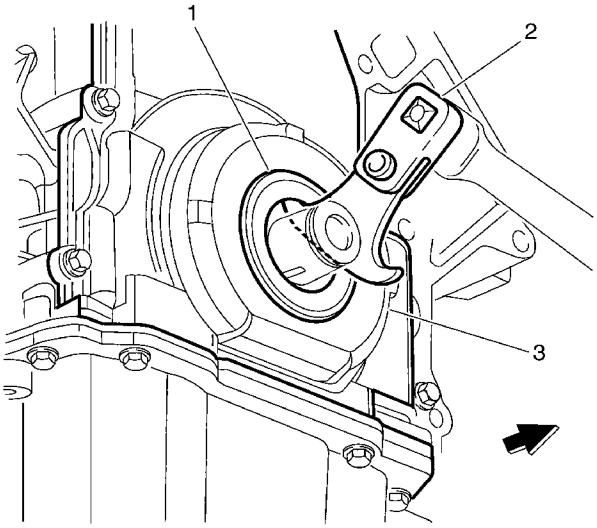
Crankshaft Front Oil Seal Replacement

Tools Required

- J 41478 Crankshaft Front Oil Seal Installer
- E-308 Crankshaft Front Oil Seal Remover.

Removal Procedure

1. Disconnect the battery. Refer to Battery Negative Cable Disconnection and Connection.
2. Remove the radiator. Refer to Radiator Replacement.
3. Remove the accessory drive belt. Refer to Drive Belt Replacement - Accessory.
4. Remove the air conditioning (A/C) drive belt. Refer to Air Conditioning Compressor Belt Replacement.
5. Remove the starter motor. Refer to Starter Motor Replacement.
6. Remove the crankshaft balancer. Refer to Crankshaft Balancer Removal.



7. Using tool E-308 (2) gently pry the crankshaft oil seal (1) from the front engine cover (3).

Installation Procedure

1. Install the crankshaft front oil seal installation. Refer to Crankshaft Front Oil Seal Installation.
2. Install the crankshaft balancer. Refer to Crankshaft Balancer Installation.
3. Install the starter motor. Refer to Starter Motor Replacement.
4. Install the air conditioning (A/C) drive belt. Refer to Air Conditioning Compressor Belt Replacement.
5. Install the accessory drive belt. Refer to Drive Belt Replacement - Accessory.
6. Install the radiator. Refer to Radiator Replacement.
7. Connect the battery. Refer to Battery Negative Cable Disconnection and Connection.

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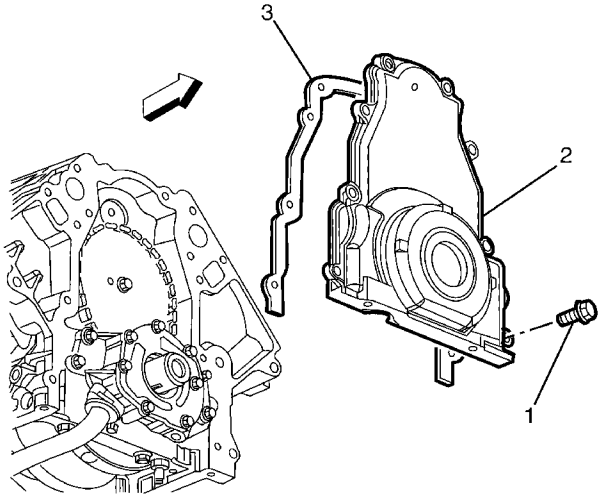
Engine Front Cover Replacement

Tools Required

- J 41480 Front and Rear Cover Alignment
- J 41476 Front and Rear Cover Alignment Tool

Removal Procedure

1. Remove the oil pan. Refer to Oil Pan Replacement.
2. Remove the crankshaft balancer. Refer to Crankshaft Balancer Removal.



3. Remove the engine front cover to cylinder block retaining bolts (1).

Important: The engine front cover gasket (3) is a single use only component and must be replaced whenever the engine front cover (2) is removed.

4. Remove the engine front cover (2) and gasket (3).
5. Remove the engine front cover gasket (3).

Discard the engine front cover gasket (3).

6. Clean and inspect the engine front cover. Refer to Engine Front Cover Cleaning and Inspection.

Installation Procedure

1. Install the engine front cover. Refer to Engine Front Cover Installation.
2. Install the crankshaft balancer. Refer to Crankshaft Balancer Removal.

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3. Install the oil pan. Refer to Oil Pan Replacement.

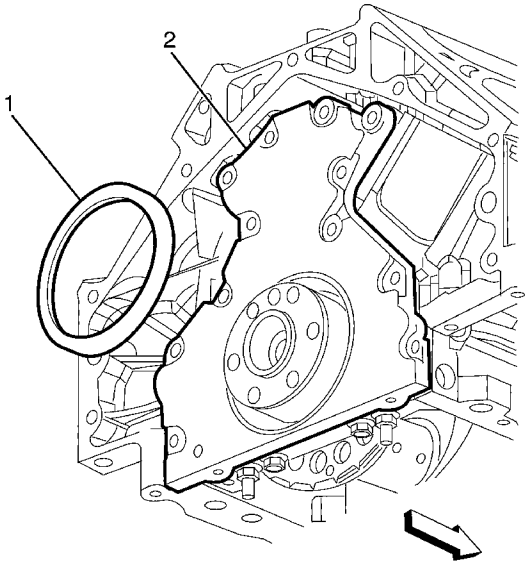
Crankshaft Rear Oil Seal Replacement

Tools Required

J 41479 Crankshaft Rear Oil Seal Installer

Removal Procedure

1. Remove the engine flywheel. Refer to Engine Flywheel Replacement.



2. Gently pry the crankshaft rear oil seal (1) from the rear cover (2).

Installation Procedure

1. Install the crankshaft rear seal. Refer to Crankshaft Rear Oil Seal Installation.
2. Install the engine flywheel. Refer to Engine Flywheel Replacement.

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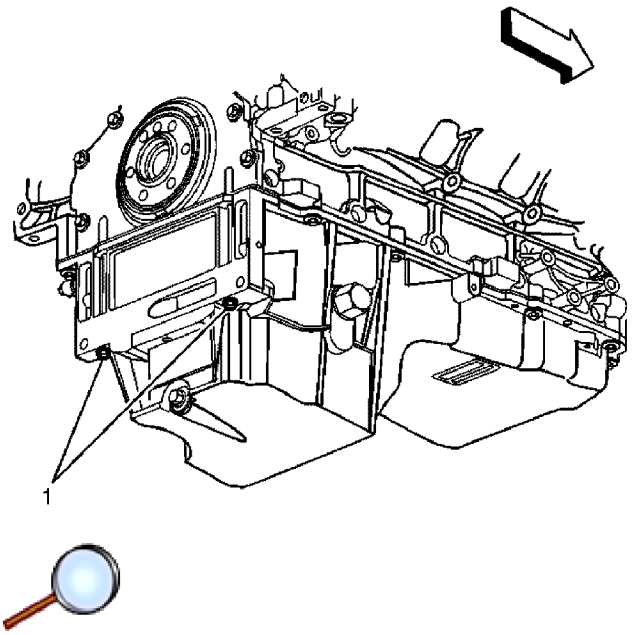
Crankshaft Rear Oil Seal Housing Replacement

Removal Procedure

Tools Required

- J 41476
- J 41479

1. Remove the transmission assembly. Refer to Transmission Replacement.
2. Remove the flywheel assembly. Refer to Engine Flywheel Removal.



3. Remove the oil pan to rear oil seal housing bolts (1).

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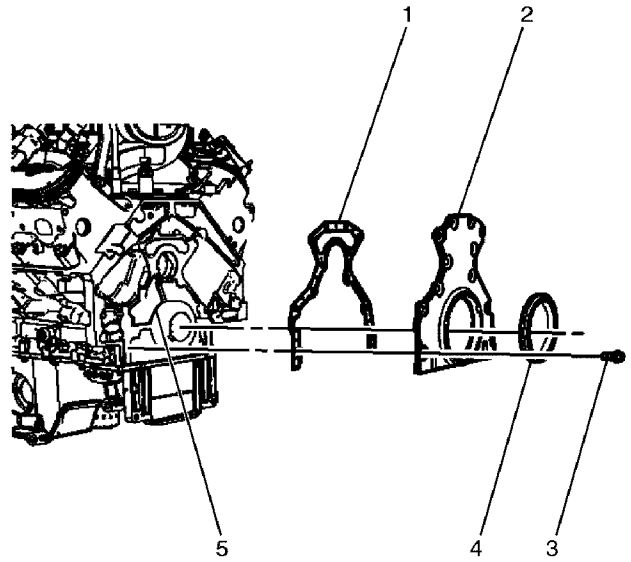


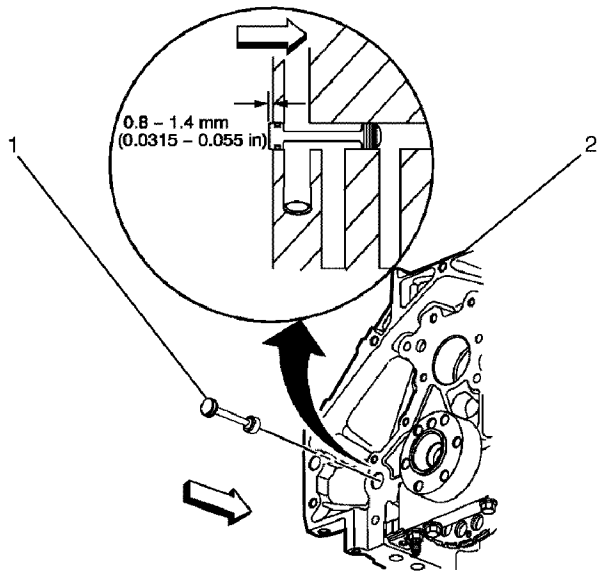
4. Remove the rear oil seal housing to engine block bolts (3).
5. Remove the rear oil seal housing (2) from the engine block (5).
6. Remove the rear oil seal housing gasket (1) from the engine block (5).

   Discard the rear oil seal housing gasket (1).

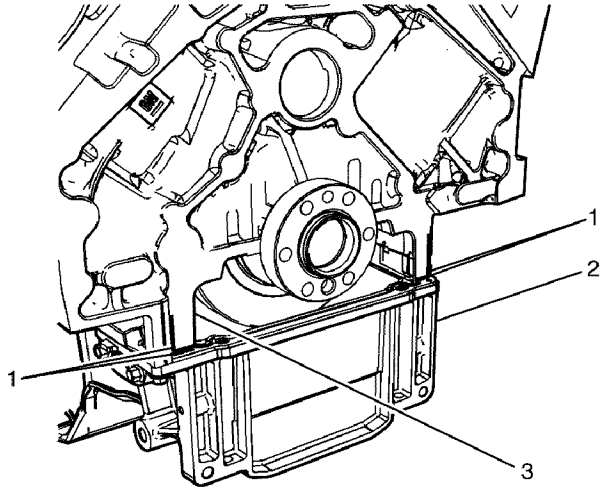
7. Remove the rear crankshaft oil seal (4) from the rear oil seal housing (2).

   Discard the rear oil seal (4).

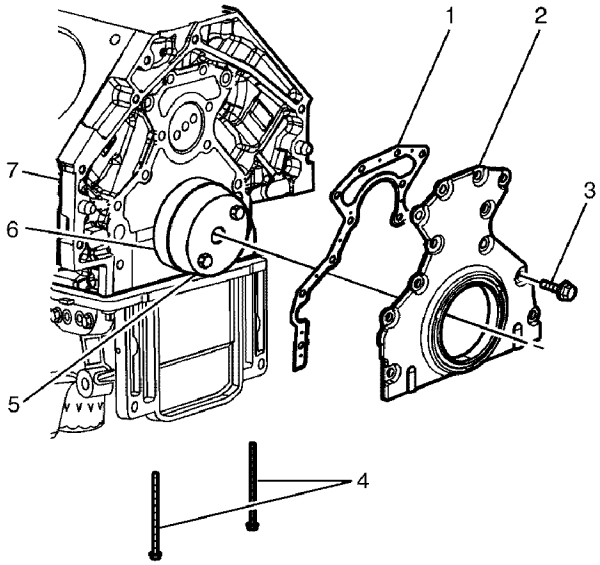
Installation Procedure - Cover with Seal



1. Inspect the rear oil gallery plug (1) for correct installation to the engine block (2).



2. Apply a 5 mm (0.2 in) bead of sealant 20 mm (0.8 in) long to the surfaces (1) of the oil pan (2) and engine block (3).



3. Install the J 41479 (5) to the crankshaft (6).

Note: Install a new rear oil seal housing gasket (1). Failure to comply may lead to an oil leak.

Note: Make sure that the rear oil seal housing gasket contact surfaces are clean and dry. Failure to comply may lead to an oil leak.

4. Install the new rear oil seal housing gasket (1) to the engine block (7).

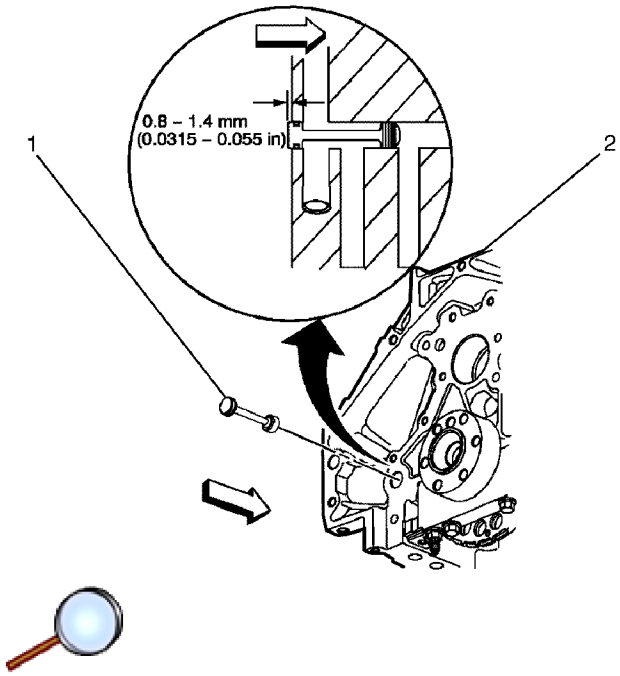
   Note: The rear oil seal housing must be aligned with J 41479 . Failure to comply may cause the rear crankshaft seal to wear prematurely.

5. Install the rear oil seal housing (2) to the engine block (7).

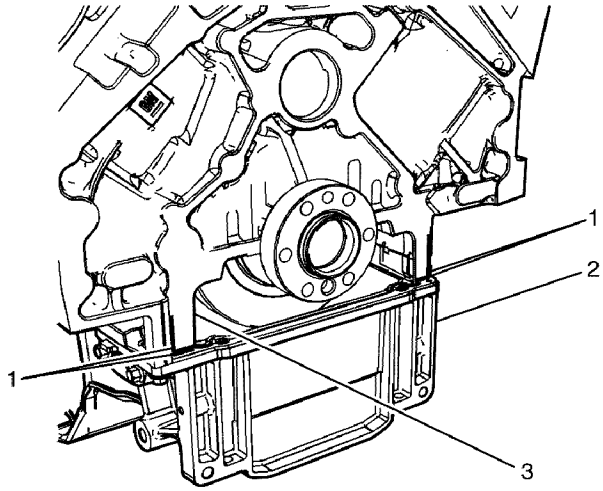
   Caution: Refer to Fastener Caution in the Preface section.

6. Install the rear oil seal housing to engine block bolts (3). Finger tighten only at this stage.
7. Install the oil pan to rear oil seal housing bolts (4) and tighten to **12 N·m (106 lb. in)**.
8. Tighten the rear oil seal housing to engine block bolts (3) and tighten to **30 N·m (22 lb. ft)**.
9. Remove the J 41479 (5) from the crankshaft (6).
10. Install the engine flywheel assembly. Refer to Engine Flywheel Replacement.
11. Install the transmission assembly. Refer to Transmission Replacement.

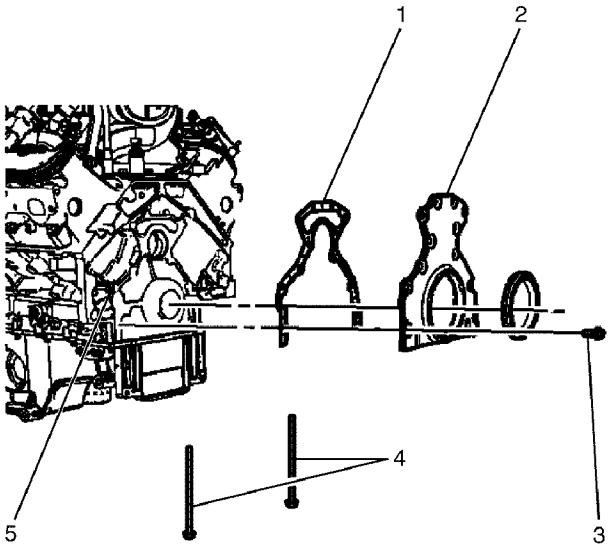
Installation Procedure - Cover without Seal



1. Inspect the rear oil gallery plug (1) for correct installation to the engine block (2).



2. Apply a 5 mm (0.2 in) bead of sealant 20 mm (0.8 in) long to the surfaces (1) of the oil pan (2) and engine block (3).

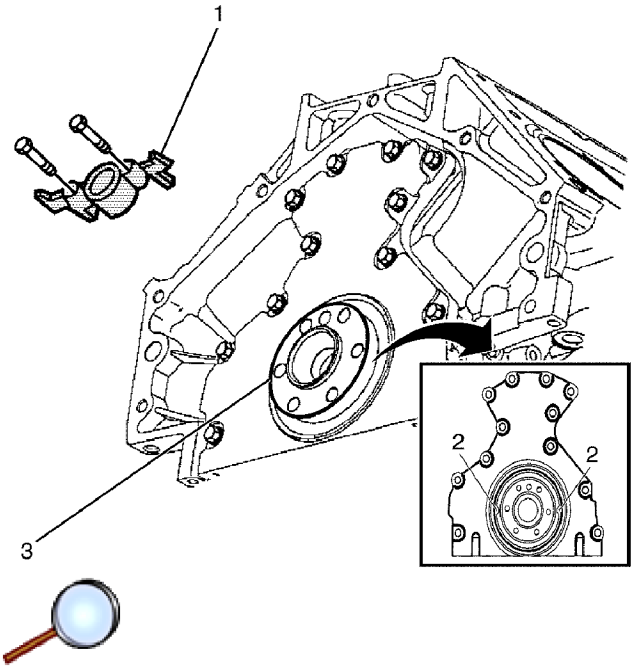


Note: Make sure that the rear oil seal housing gasket contact surfaces are clean and dry.

3. Install the new rear oil seal housing gasket (1) to the engine block (5).
4. Install the rear oil seal housing (2) to the engine block (5).

Caution: Refer to Fastener Caution in the Preface section.

5. Install the rear oil seal housing to engine block bolts (3). Finger tighten only at this stage.
6. Install the oil pan to rear housing bolts (4). Finger tighten only at this stage.

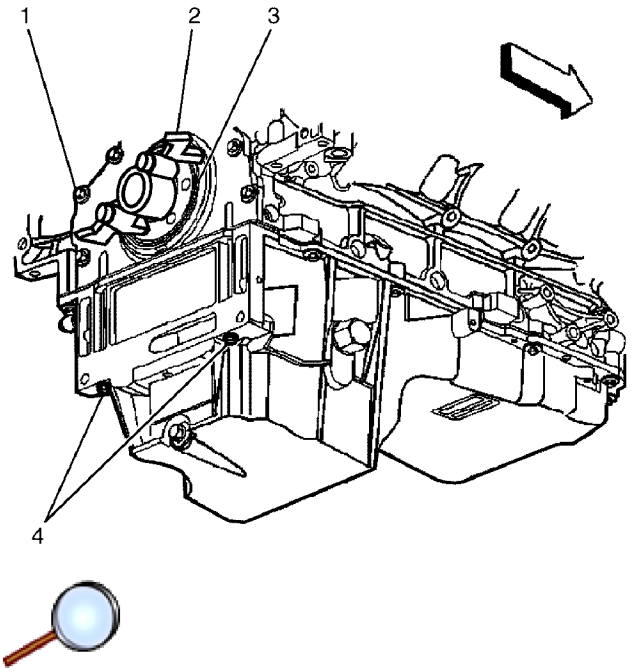


Note: The rear oil seal housing MUST be aligned to the crankshaft using J 41476 (1). Failure to comply may cause the rear crankshaft seal to wear prematurely.

Note: Align the J 41476 I (1) with the slots (2)

Note: The legs of the J 41476 (1) must enter the oil seal bore.

7. Install the J 41476 (1) to the crankshaft (3).

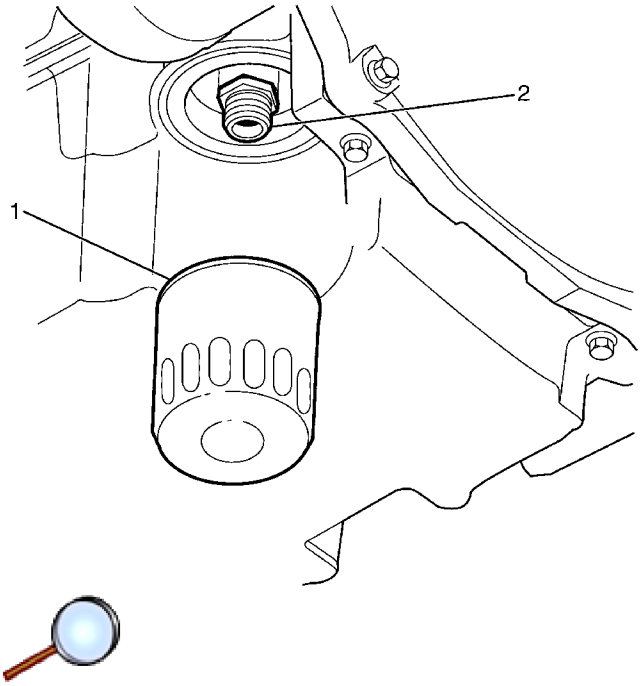


8. Tighten the oil pan to rear housing bolts (4) and tighten to **12 N·m (106 lb. in)**.
9. Tighten the rear oil seal housing to engine block bolts (1) and tighten to **30 N·m (22 lb. ft)**.
10. Remove the J 41476 (2) from the crankshaft (3).
11. Install a new crankshaft rear oil seal. Refer to Crankshaft Rear Oil Seal Replacement.

12. Install the engine flywheel assembly. Refer to Engine Flywheel Replacement.
13. Install the transmission assembly. Refer to Transmission Replacement.

Oil Filter Adapter Replacement

Removal Procedure



1. Remove the oil filter (1).
2. Remove the oil filter adapter (2).

Installation Procedure

Caution: Refer to Fastener Caution in the Preface section.

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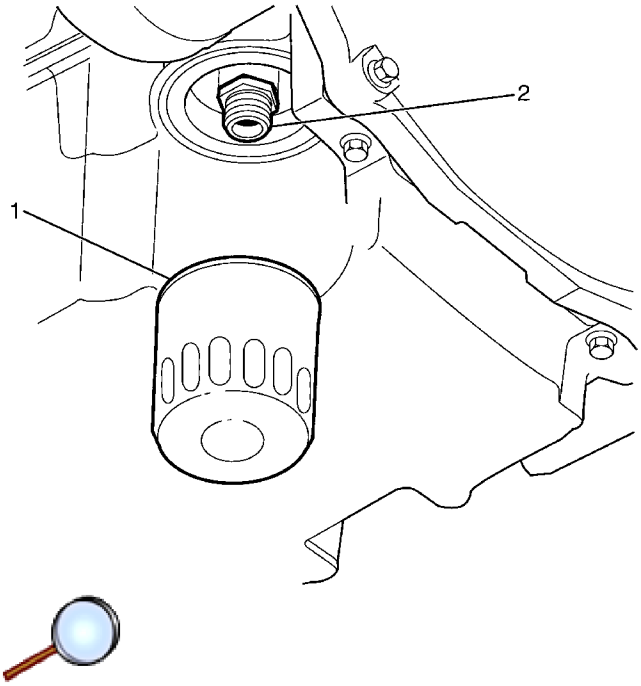
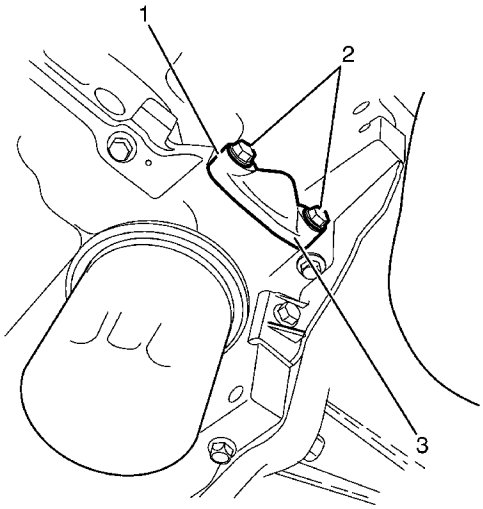


1. Install the oil filter adapter (2) and tighten to **55 N·m (40 lb ft)**.
2. Install the oil filter (1) and tighten to **30 N·m (22 lb ft)**.

Oil Pan Cover Replacement

Removal Procedure



1. Raise the vehicle. Refer to Lifting and Jacking the Vehicle.
2. Remove the oil pan cover to oil pan retaining bolts (2).
3. Remove the cover (1).
4. Remove the gasket (3).

Installation Procedure

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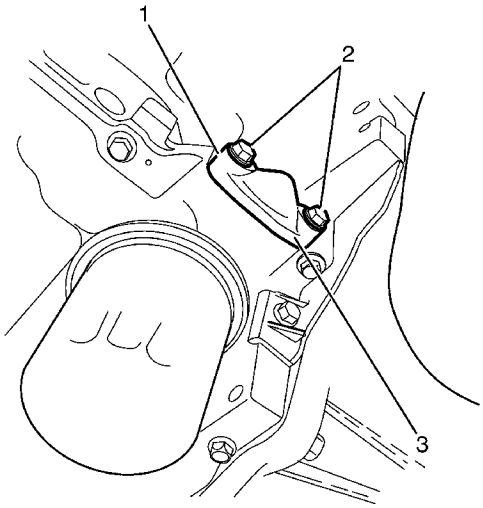


1. Position the gasket (3) and cover (1) on the engine block.

   Caution: Refer to Fastener Caution in the Preface section.

2. Install the retaining bolts (2) for the cover and tighten to **12 N·m (106 lb in)**.
3. Lower the vehicle.

Oil Pan Replacement

Removal Procedure

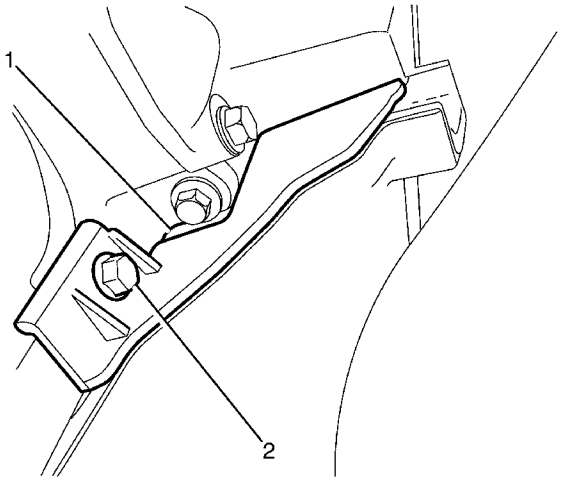
Warning: Refer to Battery Disconnect Warning in the Preface section.

1. Disconnect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.

Warning: Refer to Safety Glasses Warning in the Preface section.

Danger: To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

2. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
3. Remove the air deflector. Refer to Front Air Deflector Replacement.
4. Drain the engine oil and remove the oil filter. Refer to Engine Oil and Oil Filter Replacement.
5. Remove the engine splash shield. Refer to Engine Splash Shield Replacement.
6. Remove the starter motor. Refer to Starter Motor Replacement.



7. Remove the left side close out cover to cylinder block retaining bolt (2).
8. Remove the left side close out cover (1).

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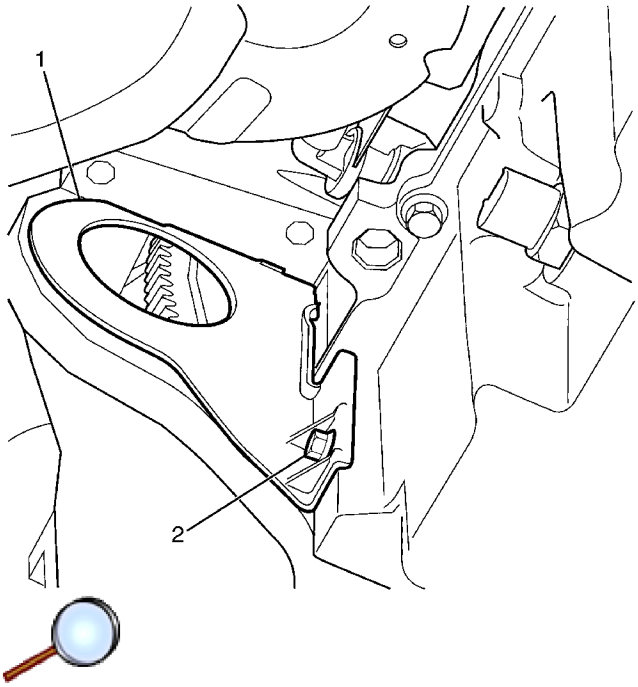
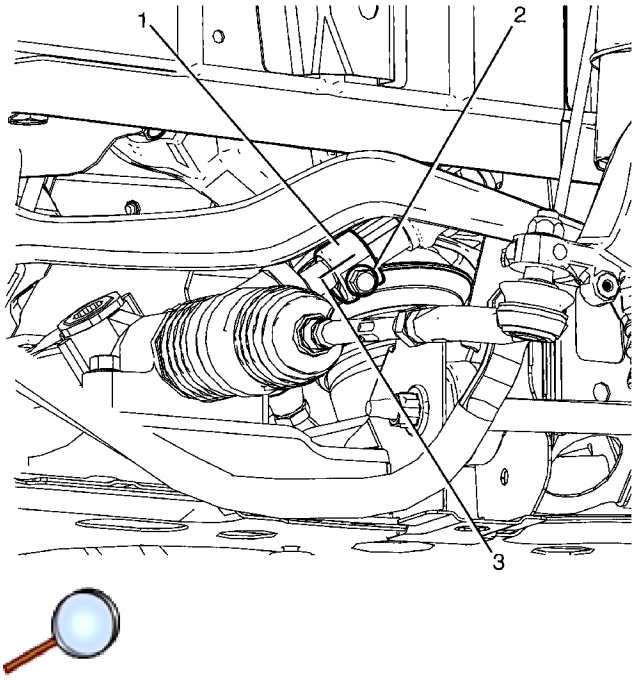


9. Remove the right side close out cover to cylinder block retaining bolt (2).
10. Remove the right side close out cover (1).



Note: Observing the orientation of the intermediate steering shaft (1) with reference to the pinion shaft (3) will minimize the potential of incorrect steering column assembly alignment.

11. Mark the intermediate steering shaft (1) in relation to the pinion shaft (3).

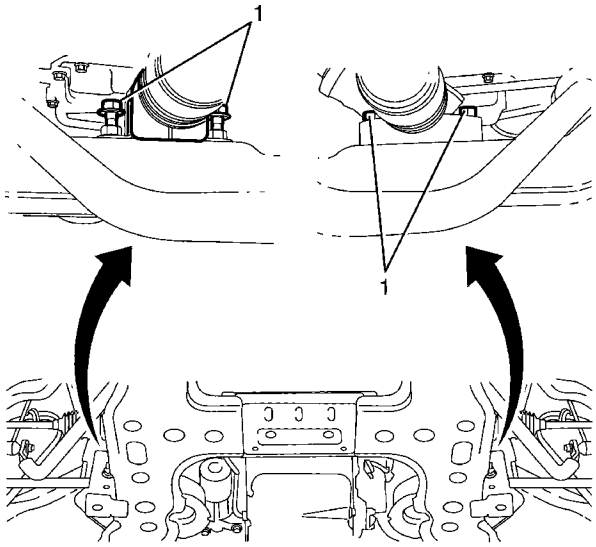
Note: Secure the steering wheel to prevent rotation otherwise damage to the SIR coil will occur.

Note: Bolts with micro-encapsulated thread sealant must be discarded after removal.

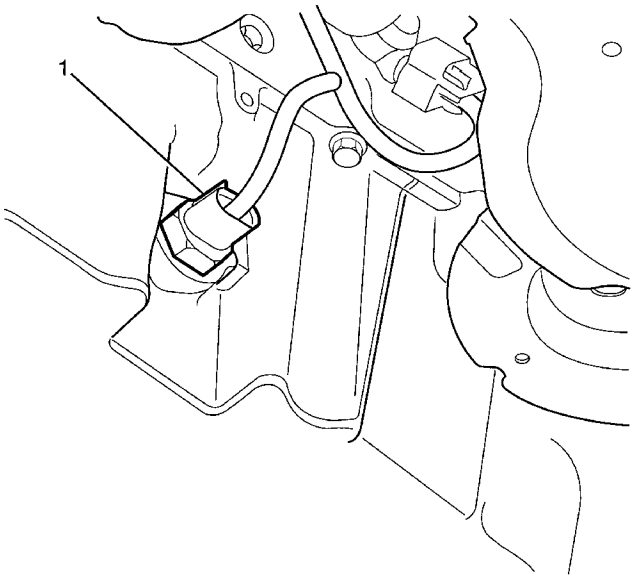
12. Remove the intermediate steering shaft to pinion shaft retaining bolt (2) and discard.

    Discard the bolt.

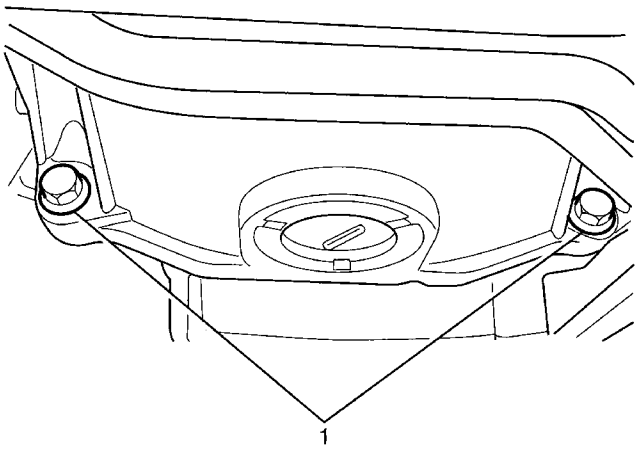
13. Disconnect the intermediate shaft (2) from the pinion shaft (3).



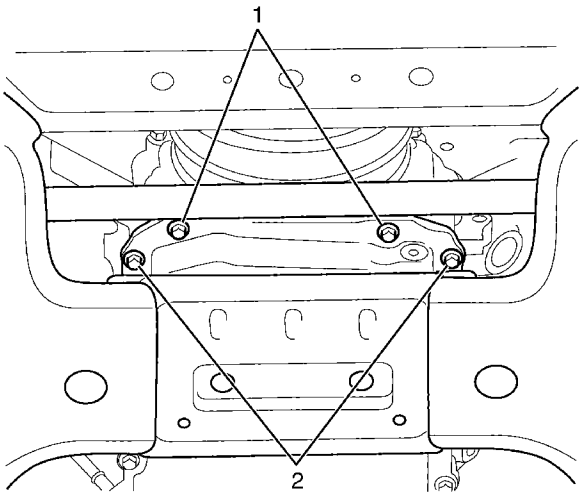
14. Remove the steering gear to sub-frame retaining bolts (1).
15. Slide the steering gear forward to gain full access to the sump.



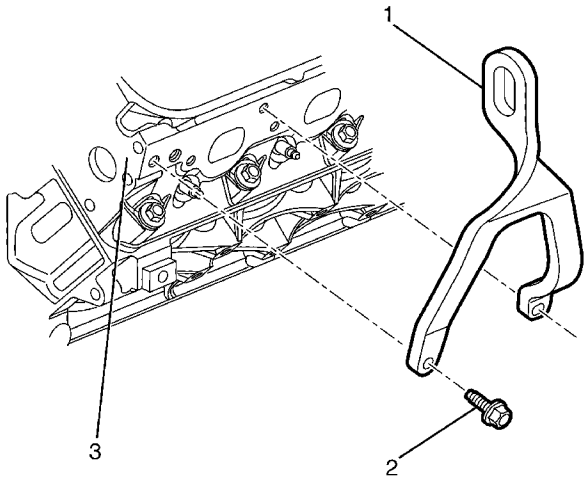
16. Disconnect the oil level/temperature sensor electrical connector (1) from the oil level/temperature sensor.



17. Remove the transmission to oil pan retaining bolts (1).



18. Remove the oil pan to front cover retaining bolts (1).
19. Remove the oil pan to cylinder block front retaining bolts (2).
20. Lower the vehicle.



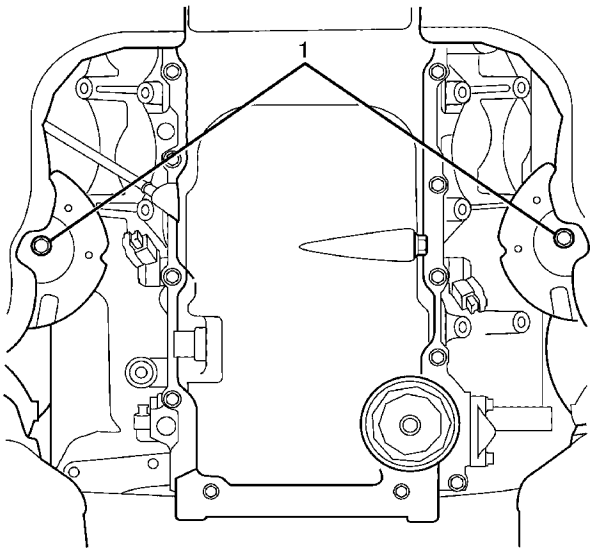
21. Position the J 41798 (1) on the cylinder head (3).

Caution: Refer to Fastener Caution in the Preface section.

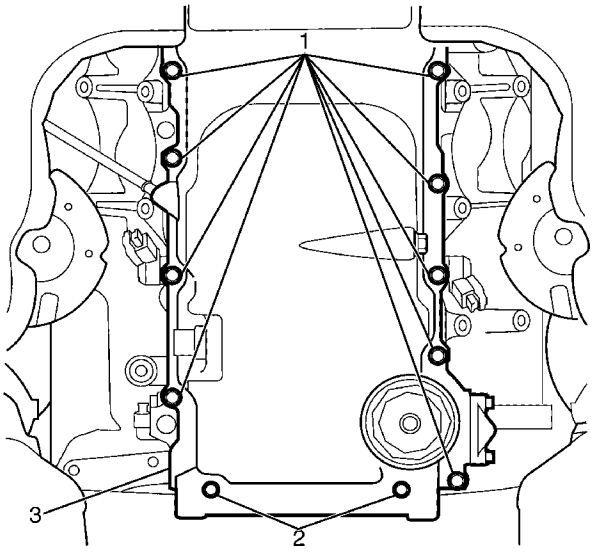
22. Install the J 41798 to cylinder head retaining bolts (2) and tighten to **50 N·m (36 lb ft)**.

Note: When lifting the engine assembly, observe the clearance between the rear of the engine assembly and the dash panel.

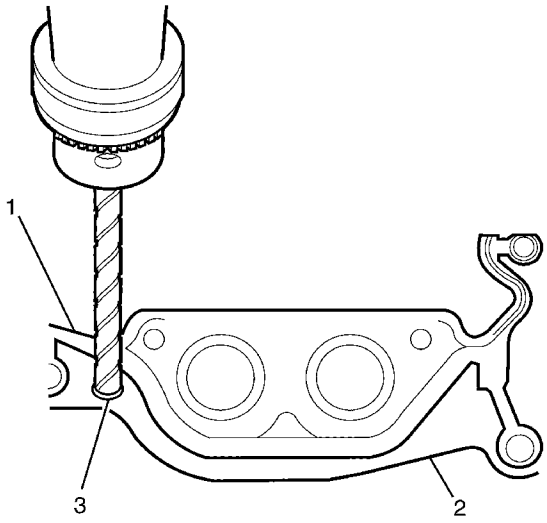
23. Install J 41803 J-41803 and J 28467-B and raise the engine assembly 20 mm.
24. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.



25. Remove the lower engine mount to crossmember retaining nut (1) from both engine mounts.



26. Remove the oil pan to engine rear cover retaining bolts (2).
27. Remove the oil pan to cylinder block retaining bolts (1).
28. Remove the oil pan (3).



Note: DO NOT allow foreign material to enter the oil passages of the oil pan, cap, or cover the openings, as required.

Note: Take care not to gouge, score, or damage the oil pan sealing surface.

29. Drill out the retaining rivets (3) from the oil pan, if required.

Note: The oil pan gasket and rivets are single use only components and must be replaced whenever the oil pan is removed from the cylinder block.

30. Remove the oil pan gasket (1) from the oil pan (2).

    Discard the gasket and rivets.

31. Clean and inspect the oil pan as necessary. Refer to Oil Pan Cleaning and Inspection.

    .

32. Clean the base of the engine block. Refer to Replacing Engine Gaskets.

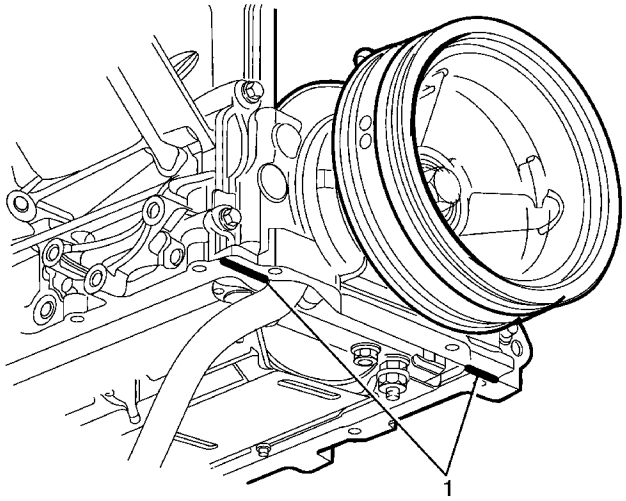
    .

Installation Procedure

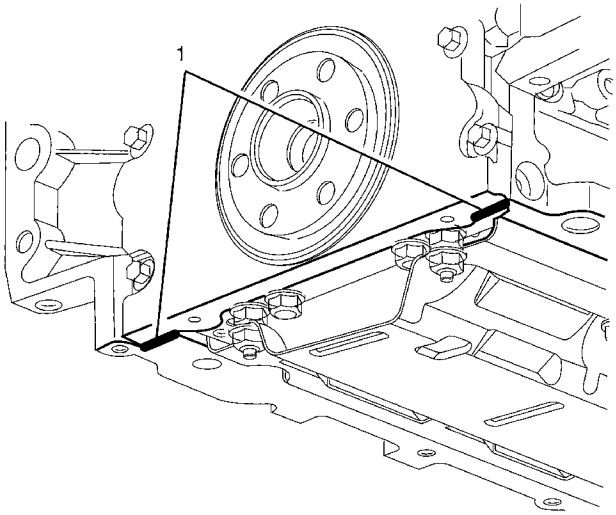
Note: The alignment of the structural oil pan is critical. The rear bolt hole locations of the oil pan provide mounting points for the transmission housing. To ensure the rigidity of the powertrain and correct transmission alignment, it is important that the rear of the block and the rear of the oil pan are flush. The rear of the oil pan must NEVER protrude beyond the engine block and transmission housing plane.

Note: The original oil pan gasket is retained and aligned to the oil pan by rivets. When installing a new gasket, it is not necessary to install new oil pan gasket rivets.

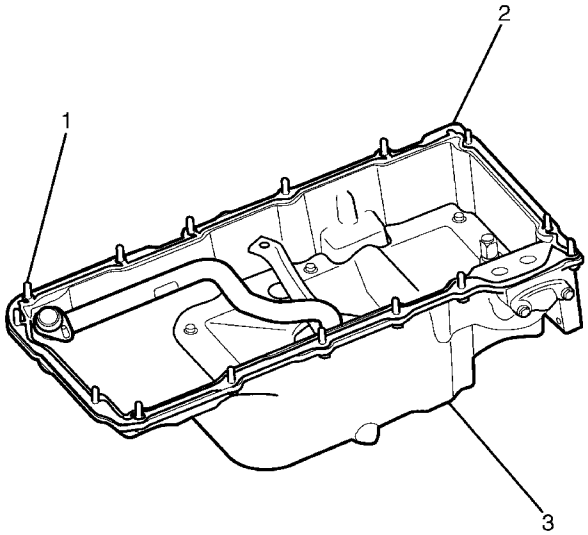
It is not necessary to rivet the NEW gasket to the oil pan.



1. Apply a 5 mm (0.2 in) bead of sealant 20 mm (0.8 in) long to the engine block (1). Apply the sealant directly onto the tabs of the front cover gasket that protrude into the oil pan surface. Refer to Adhesives, Fluids, Lubricants, and Sealers.

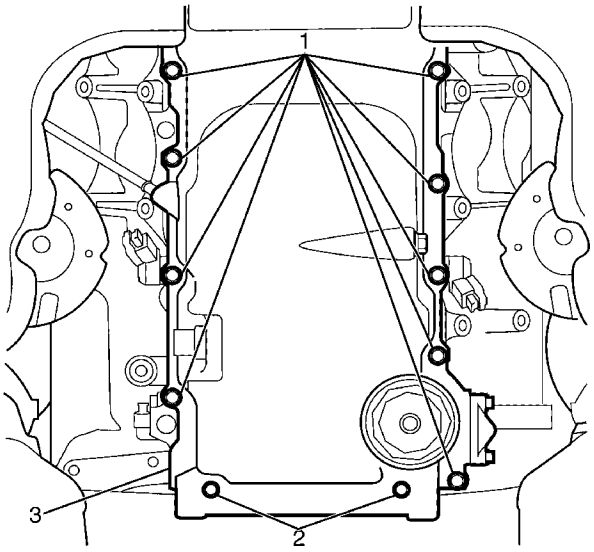


2. Apply a 5 mm (0.2 in) bead of sealant 20 mm (0.8 in) long to the engine block (1). Apply the sealant directly onto the tabs of the rear cover gasket that protrude into the oil pan surface. Refer to Adhesives, Fluids, Lubricants, and Sealers.

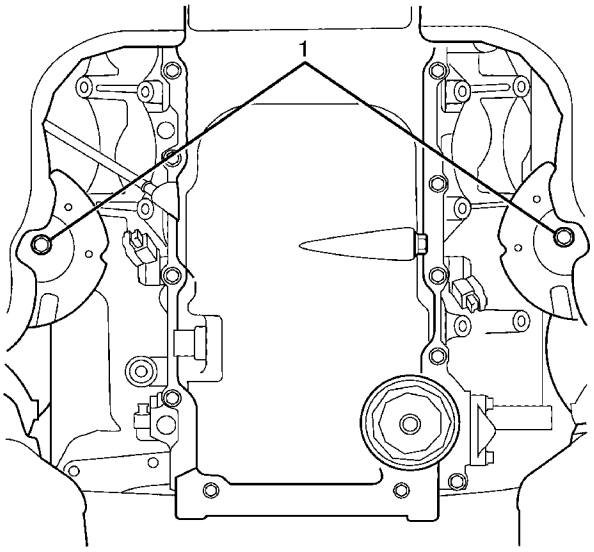


Note: Make sure to align the oil gallery passages in the oil pan and engine block correctly, with the oil pan gasket.

3. Preassemble the oil pan gasket (2) to the oil pan (3).
   3.1. Install the oil pan gasket (2) to the oil pan (3).
   3.2. Install the oil pan retaining bolts (1) to the oil pan (3) and through the oil pan gasket (2).



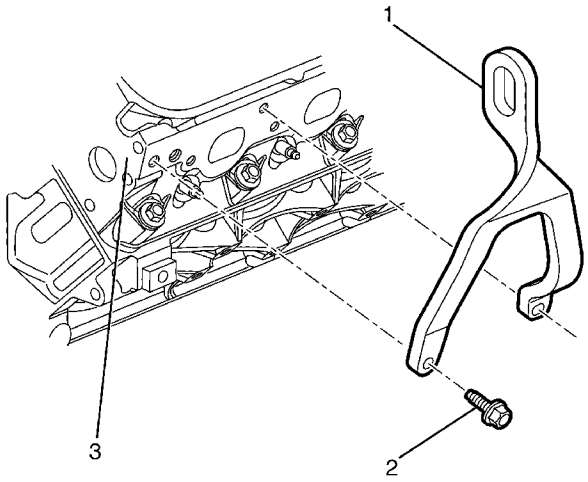
4. Install the oil pan assembly (3).
5. Install the oil pan to cylinder block retaining bolts (1) finger tight. Do not over tighten.
6. Install the oil pan to engine rear cover retaining bolts (2) finger tight. Do not over tighten.
7. Lower the vehicle.
8. Lower the engine to engage the engine mounts to the front sub-frame.



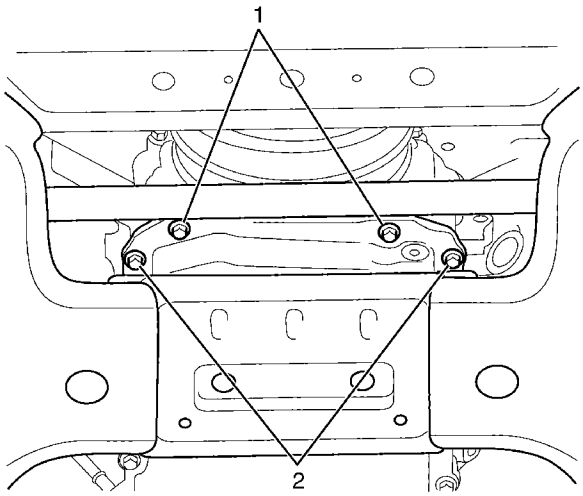
9. Raise the vehicle.

Caution: Refer to Fastener Caution in the Preface section.

10. Install the lower engine mount to front sub-frame retaining nuts (1) on both engine mounts and tighten to **80 N·m (59 lb ft)**.
11. Lower the vehicle.
12. Remove J 41803 and J 28467-B from the engine.



13. Remove the J 41798 to cylinder head retaining bolts (2).
14. Remove the J 41798 (1) from the cylinder head (3).



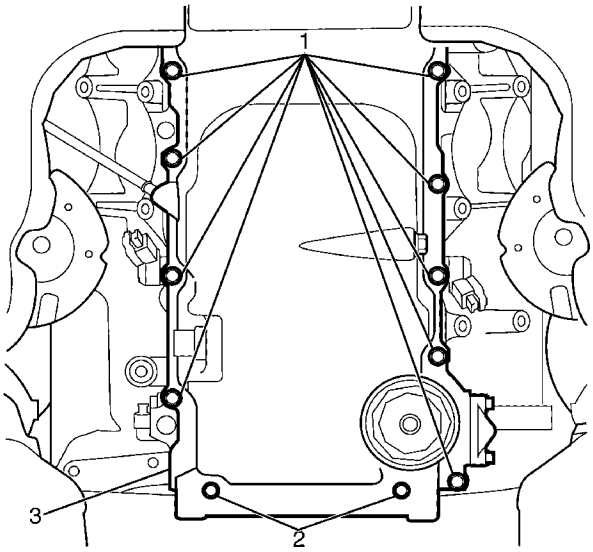
15. Install the oil pan to front cover retaining bolts (1) finger tight. Do not over tighten.
16. Install the oil pan to cylinder block retaining bolts (2) finger tight. Do not over tighten.
17. Place a straight edge across the rear of the engine block and the rear of the oil pan at the transmission housing mounting surfaces.
18. Align the oil pan until the rear of engine block and the rear of oil pan are flush or even.
19. Measure the oil pan-to-engine block alignment.
    19.1. Place a straight edge across the rear of the engine block and rear of the oil pan at the transmission housing mounting surfaces.

Note: The rear of the oil pan must NEVER protrude beyond the engine block and transmission housing mounting surfaces.

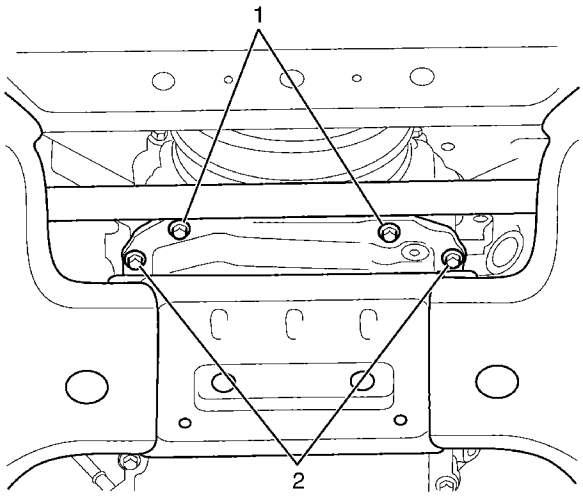
19.2. Insert a feeler gage between the straight edge and the oil pan transmission housing mounting surface and check to make sure that there is no more than a 0.25 mm (0.01 in) gap between the pan and the straight edge.

19.3. If the oil pan alignment is not within specifications, remove the oil pan and repeat procedures 17-19.

Caution: Refer to Fastener Caution in the Preface section.

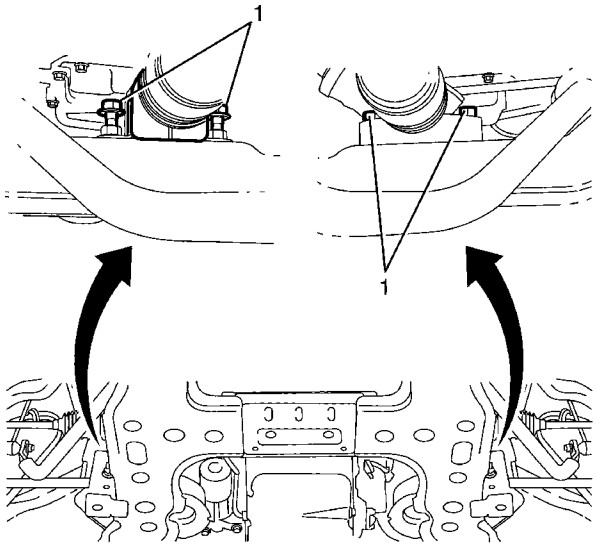


20. Tighten the oil pan to cylinder block retaining bolts (1) to **25 N·m (18 lb ft)**.
21. Tighten the oil pan to engine rear oil seal housing retaining bolts (2) to **12 N·m (106 lb in)**.

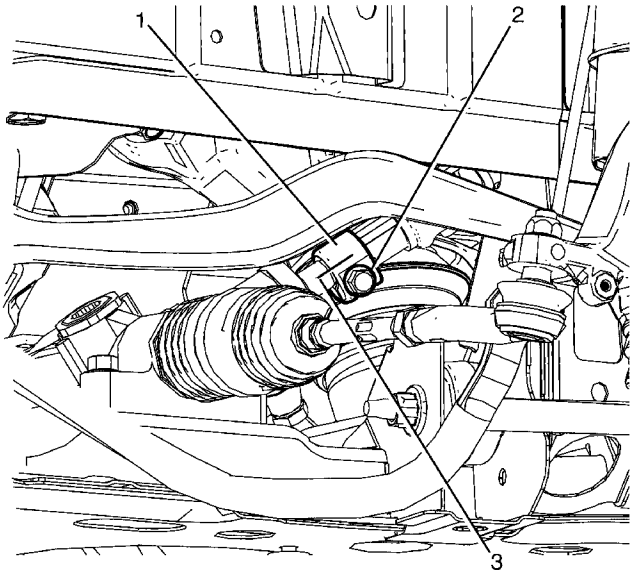


22. Tighten the oil pan to cylinder block retaining bolts (2) to **25 N·m (18 lb ft)**.
23. Tighten the oil pan to front cover retaining bolts (1) to **25 N·m (18 lb ft)**.

24. Position the steering gear in the correct location.

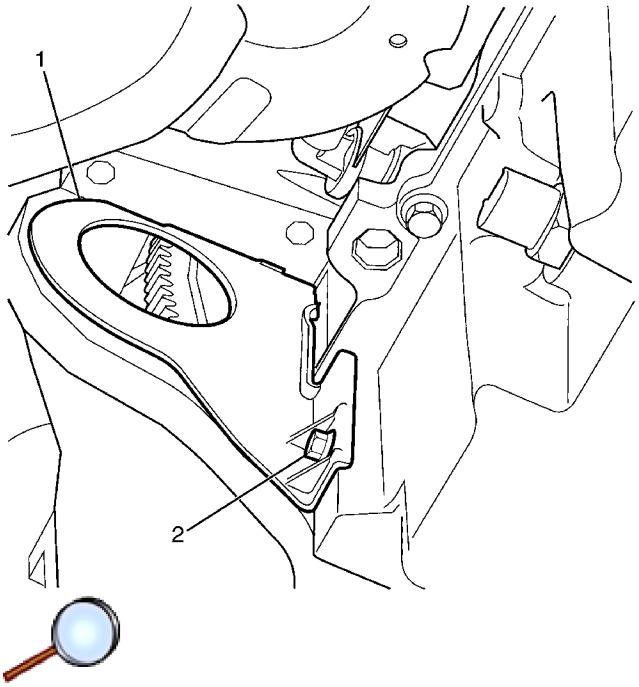


25. Install the steering gear to sub-frame retaining bolts (1) and tighten to **65 N·m (48 lb ft)**.

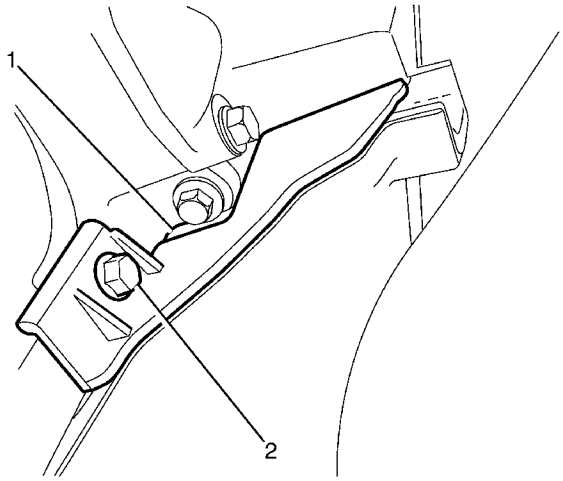


Note: The intermediate steering shaft and pinion shaft splines must be installed in the position recorded during removal and aligned with the marks previously made.

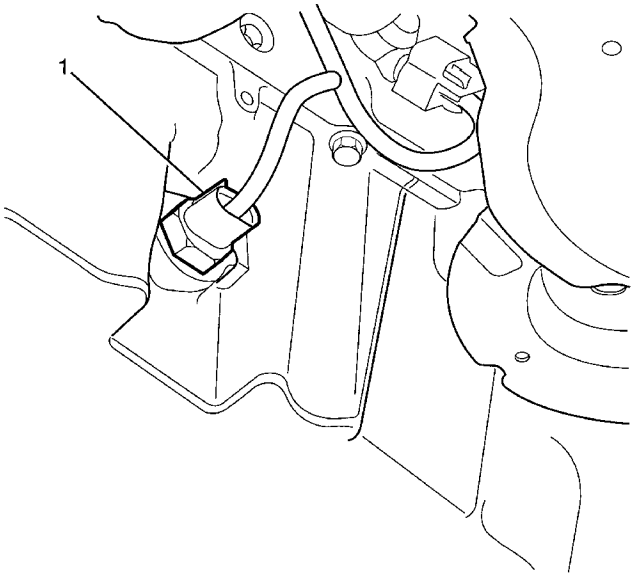
26. Connect the intermediate steering shaft (1) to the pinion shaft (3).
27. Install the intermediate steering shaft to pinion shaft NEW retaining bolt (2) and tighten to **25 N·m (18 lb ft)**.



28. Install the right side close out cover (1).
29. Install the right side close out cover to cylinder block retaining bolt (2) and tighten to **12 N·m (106 lb in)**.



30. Install the left side close out cover (1).
31. Install the left side close out cover to cylinder block retaining bolt (2) and tighten to **12 N·m (106 lb in)**.



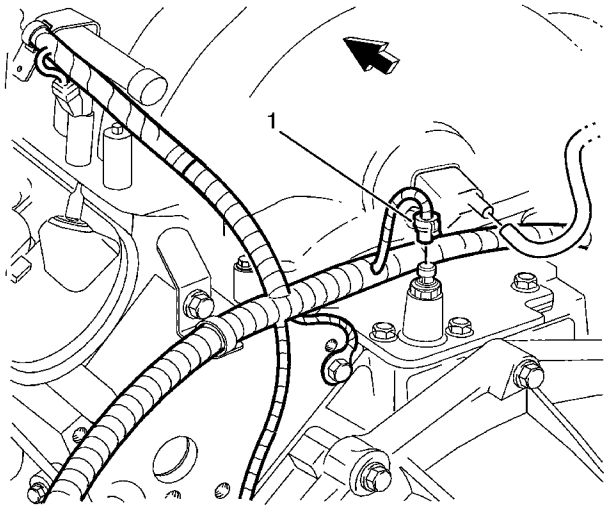
32. Connect the oil level/temperature sensor electrical connector (1) to the oil level/temperature sensor.
33. Install the starter motor. Refer to Starter Motor Replacement.
34. Install the air deflector. Refer to Front Air Deflector Replacement.
35. Install the engine splash shield. Refer to Engine Splash Shield Replacement.
36. Lower the vehicle to the ground
37. Connect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.
38. Replace the engine oil and oil filter. Refer to Engine Oil and Oil Filter Replacement.

Engine Oil Pressure Sensor and/or Switch Replacement

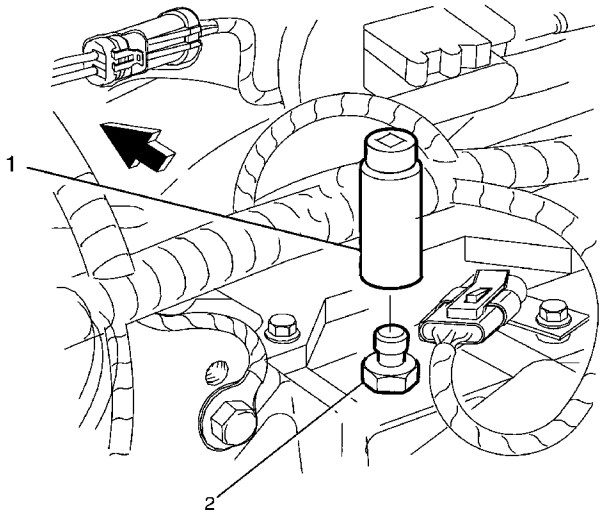
Tools Required

J 41712 Oil Pressure Switch Socket

Removal Procedure



1. Disconnect the oil pressure sensor wiring harness connector (1).



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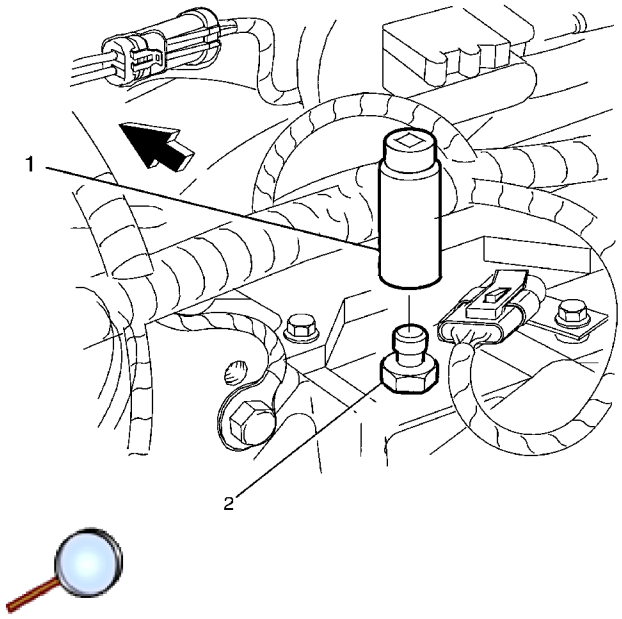
Note: Clean the area around the oil pressure sensor (2) before removal. This prevents debris from entering the engine.

2. Use the J 41712 (1) to remove the oil pressure sensor (2).

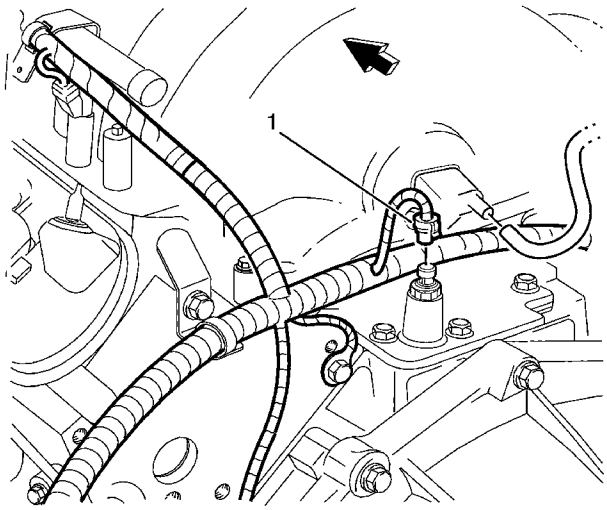
Installation Procedure

Caution: Refer to Fastener Caution in the Preface section.



Note: If installing the old oil pressure sensor (2), apply sealant GM P/N 12346004 (Canadian P/N 10953480) or equivalent to the cleaned oil pressure sensor (2) thread.

1. Install the oil pressure sensor (2) using the J 41712 (1) and tighten to **35 N·m (26 lb ft)**.



2. Connect the oil pressure sensor electrical connector (1).

Engine Oil Level Sensor and/or Switch Replacement

Removal Procedure

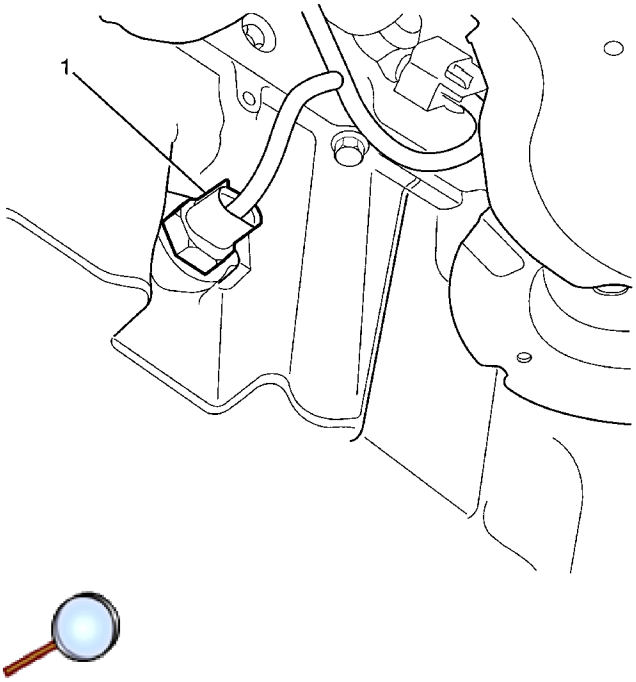
Warning: Refer to Battery Disconnect Warning in the Preface section.

1. Disconnect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.

Warning: Refer to Safety Glasses Warning in the Preface section.

Danger: To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

2. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
3. Drain the engine oil. Refer to Engine Oil and Oil Filter Replacement.



4. Disconnect the oil level/temperature sensor electrical connector (1).

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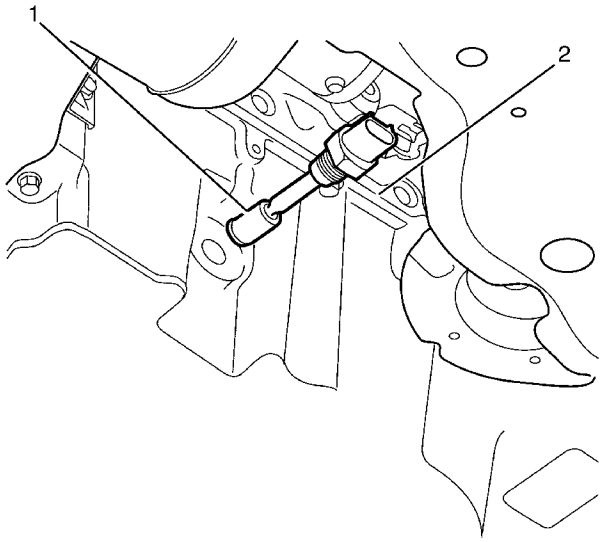
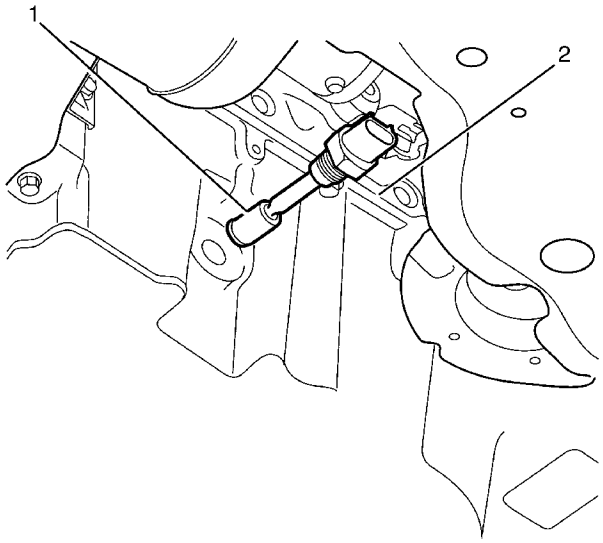


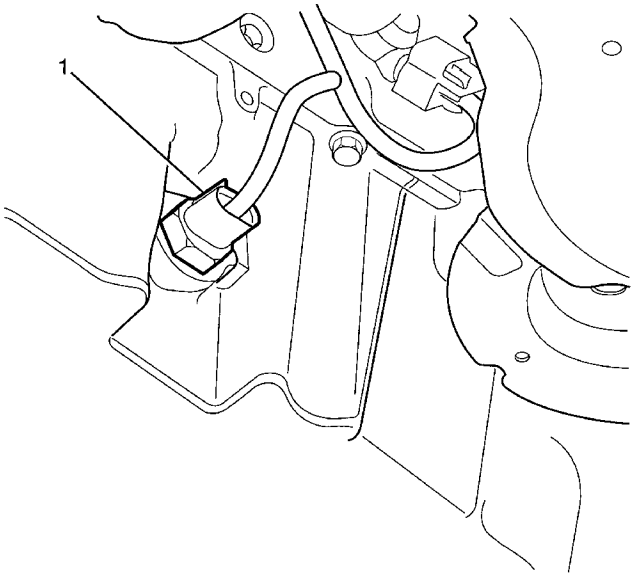
5. Remove the engine oil lever sensor (1) from the oil pan (2).

Installation Procedure

Caution: Refer to Fastener Caution in the Preface section.



1. Install the engine oil level sensor (1) to the oil pan (2) and tighten to **20 N·m (15 lb ft)**.

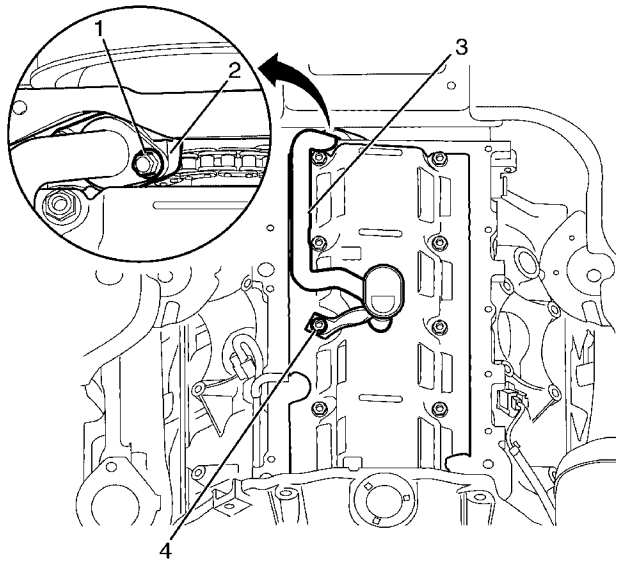


2. Connect the oil level/temperature sensor electrical connector (1).
3. Lower the vehicle.
4. Replace the engine oil and oil filter. Refer to Engine Oil and Oil Filter Replacement.
5. Reset the GM Oil Life System. Refer to GM Oil Life System Resetting.

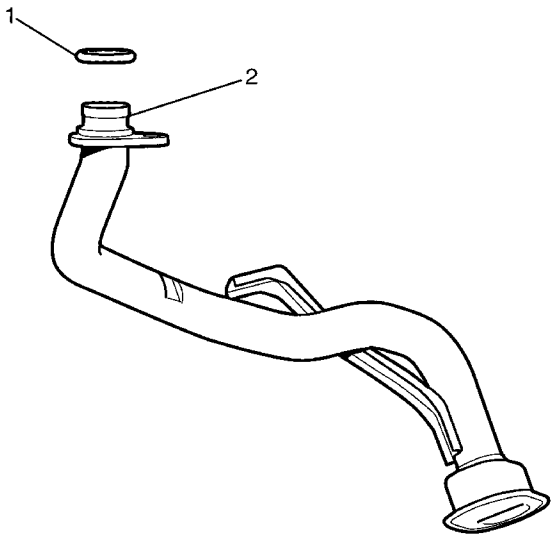
Oil Pump, Screen, and Crankshaft Oil Deflector Replacement

Removal Procedure

1. Remove the engine oil pan. Refer to Oil Pan Replacement.
2. Remove the engine front cover. Refer to Engine Front Cover Replacement.



3. Remove the oil pump screen and tube assembly to oil pump retaining bolt (1).
4. Remove the oil pump screen and tube assembly to crankshaft oil deflector retaining nut (4).
5. Remove the oil pump screen and tube assembly (3) from the oil pump (2).



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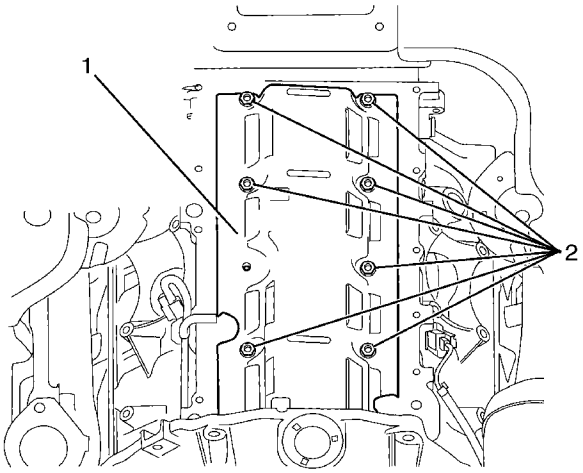
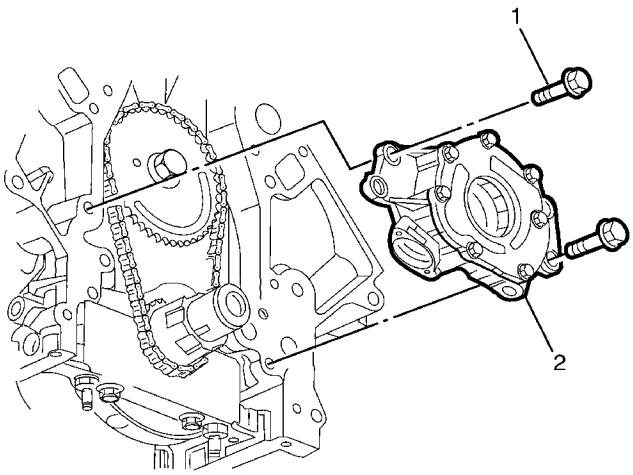
Note: The oil pump screen and tube assembly O-ring seal (1) is a single use only component and must be replaced whenever the oil pump screen and tube assembly (2) is removed.

6. Remove the oil pump screen and tube assembly O-ring seal (1) from the oil pump screen and tube assembly (2).

   Discard the oil pump screen and tube assembly O-ring seal (1).



7. Remove the remaining crankshaft oil deflector retaining nuts (2).
8. Remove the crankshaft oil deflector (1).

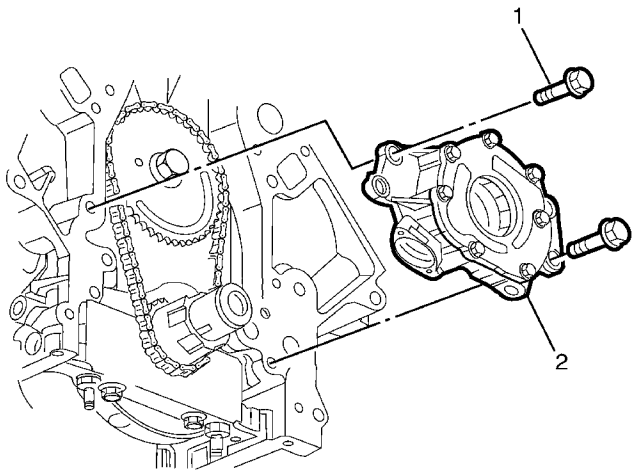


9. Remove the oil pump bolts (1).

Note: Do not allow dirt or debris to enter the oil pump. Cap the ends as necessary.

10. Remove the oil pump (2).
11. Clean and inspect the oil pump. Refer to Oil Pump Cleaning and Inspection.

Installation Procedure

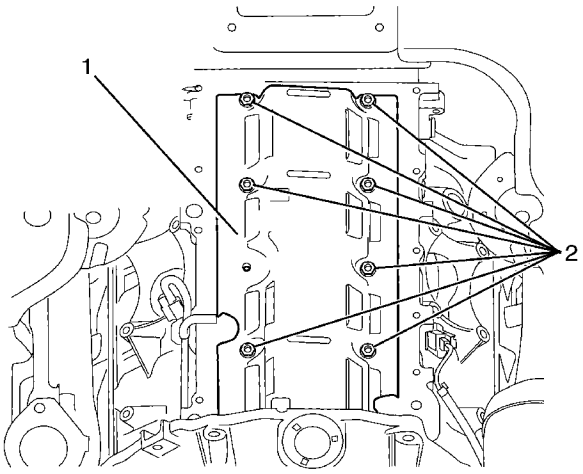


Note: Inspect the engine block oil gallery passages. These surfaces must be clear and free of debris or restrictions.

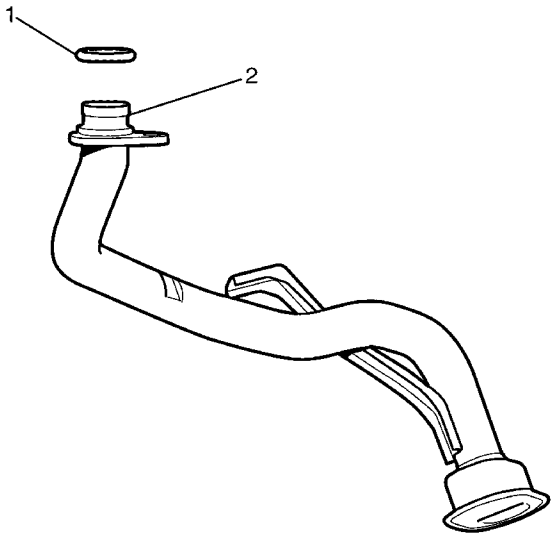
1. Align the splined surfaces of the crankshaft sprocket and the oil pump drive gear and install the oil pump (1).

Caution: Refer to Fastener Caution in the Preface section.

2. Install the oil pump to engine block retaining bolts (2) and tighten to **25 N·m (18 lb ft)**.



3. Install the crankshaft oil deflector (1).
4. Install the crankshaft oil deflector retaining nuts (2) and tighten to **25 N·m (18 lb ft)**.



5. Lubricate a NEW oil pump screen and tube assembly O-ring seal (1) with clean engine oil.
6. Install the NEW oil pump screen and tube assembly O-ring seal (1) onto the oil pump screen and tube assembly (2).

Note: Push the oil pump screen and tube assembly (3) completely into the oil pump (2) prior to tightening the oil pump screen and tube assembly to oil pump retaining bolt (1). Do not allow the oil pump screen and tube assembly to oil pump retaining bolt (1) to pull the oil pump screen and tube assembly (3) into the oil pump (2).

Note: Align the oil pump screen brackets with the correct crankshaft bearing cap studs.

7. Install the oil pump screen and tube assembly (3).
8. Install the oil pump screen and tube assembly to oil pump retaining bolt (1) and tighten to **12 N·m (106 lb in)**.
9. Install the oil pump screen and tube assembly to crankshaft oil deflector retaining nut (4) and tighten to **25 N·m (18 lb ft)**.
10. Install the engine front cover. Refer to Engine Front Cover Replacement.
11. Install the engine oil pan. Refer to Oil Pan Replacement.

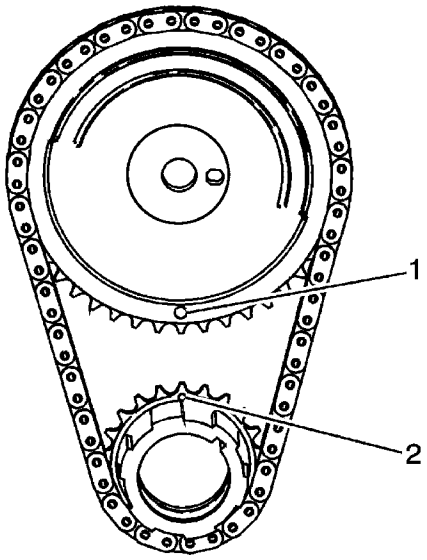
Camshaft Timing Chain and Sprocket Replacement

Special Tools

- EN 46330 EN-46330 Timing Chain Tensioner Retaining Pin
- J 8433-1 Puller Bar
- J 41478 Crankshaft Front Oil Seal Installer
- J 41558 Crankshaft Sprocket Remover
- J 41665 Crankshaft Balancer and Sprocket Installer
- J 41816-2 Crankshaft End Protector
- J 45059 Angle Meter

Removal Procedure

1. Remove the crankshaft balancer. Refer to Crankshaft Balancer Replacement.
2. Remove the engine front cover. Refer to Engine Front Cover Replacement.
3. Remove the oil pump. Refer to Oil Pump, Screen, and Crankshaft Oil Deflector Replacement.



Caution: Do not turn the crankshaft assembly after the timing chain has been removed in order to prevent damage to the piston assemblies or the valves.

4. Inspect the sprockets for correct alignment. The mark on the camshaft sprocket (1) should be located in the 6 o'clock position and the mark on the crankshaft sprocket (2) should be located in the 12 o'clock position.
5. Remove the timing chain and sprockets. Refer to Timing Chain and Sprocket Removal.

Installation Procedure

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1. Install the timing chain and sprockets. Refer to Timing Chain and Sprocket Installation.
2. Install the oil pump. Refer to Oil Pump, Screen, and Crankshaft Oil Deflector Replacement.
3. Install the engine front cover. Refer to Engine Front Cover Replacement.
4. Install the crankshaft balancer. Refer to Crankshaft Balancer Replacement.

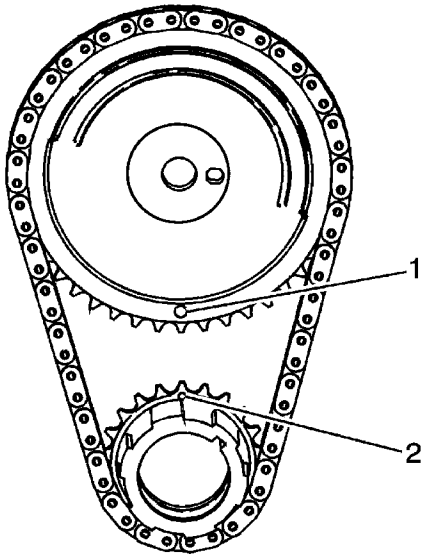
Camshaft Replacement

Special Tools

J 41476 J-41476 Front and Rear Cover Alignment Tool

Removal Procedure

1. Remove the engine assembly. Refer to Engine Replacement.
2. Remove the oil level indicator tube. Refer to Oil Level Indicator and Tube Removal.
3. Remove the left and right exhaust manifolds. Refer to Exhaust Manifold Replacement - Left Side and Exhaust Manifold Replacement - Right Side.
4. Remove the intake manifold. Refer to Intake Manifold Removal.
5. Remove the coolant air bleed pipe. Refer to Coolant Air Bleed Pipe Assembly Replacement.
6. Remove the left and right valve rocker arm covers. Refer to Valve Rocker Arm and Push Rod Replacement and Valve Stem Oil Seal and Valve Spring Replacement.
7. Remove the valve rocker arms and push rods. Refer to Oil Level Indicator and Tube Replacement.
8. Remove the left and right cylinder heads. Refer to Cylinder Head Replacement - Left Side and Cylinder Head Replacement - Right Side.
9. Remove the valve lifters. Refer to Valve Lifter Replacement.
10. Remove the water pump. Refer to Water Pump Removal.
11. Remove the crankshaft balancer. Refer to Crankshaft Balancer Removal.
12. Remove the engine front cover. Refer to Engine Front Cover Replacement.



13. Inspect the sprockets for correct alignment. The mark on the camshaft sprocket (1) should be located in the 6 o'clock position and the mark on the crankshaft sprocket (2) should be located in the 12 o'clock position.

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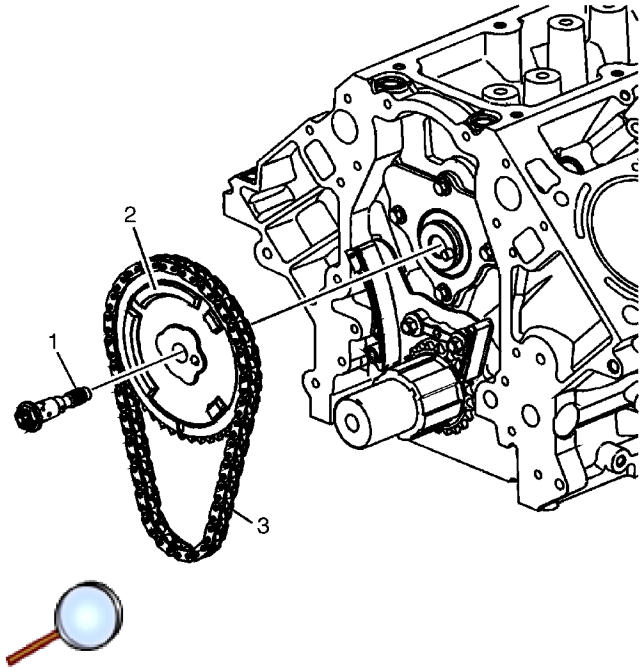


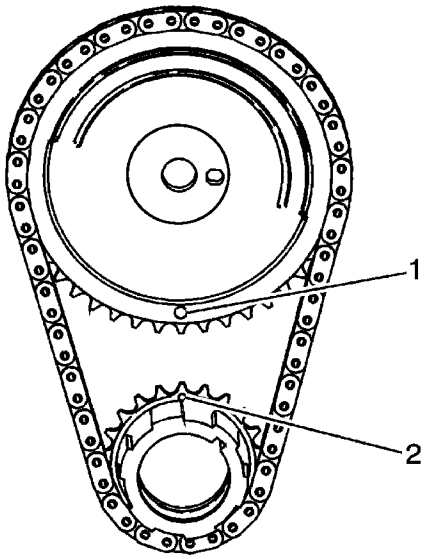
Caution: Do not turn the crankshaft assembly after the timing chain has been removed in order to prevent damage to the piston assemblies or the valves.

14. Remove the camshaft sprocket bolt (1).
15. Remove the camshaft sprocket (2) and timing chain (3).
16. Remove the camshaft. Refer to Camshaft Removal.

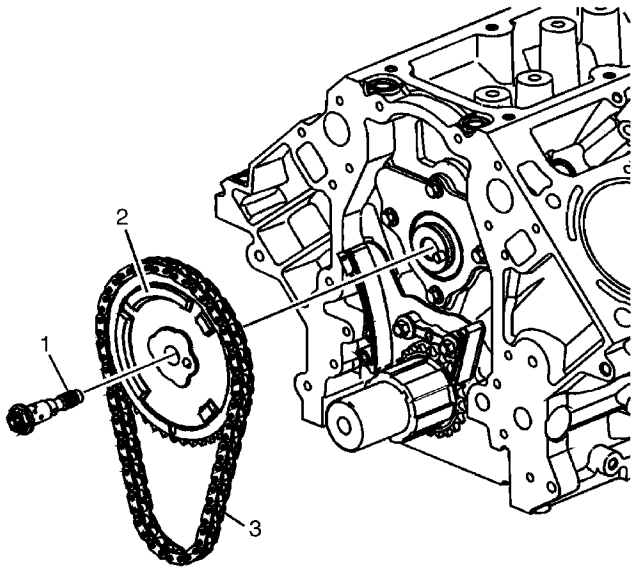
Installation Procedure

Note: If camshaft replacement is required, the valve lifters must also be replaced.

1. Install the camshaft. Refer to Camshaft Installation.



2. Align the camshaft sprocket alignment mark (1, 2), in the 6 o'clock position.



3. Install the camshaft sprocket (1) and timing chain (2).

Caution: Refer to Fastener Caution in the Preface section.

4. Install the camshaft sprocket to camshaft retaining bolt (1) and tighten to **25 N·m (18 lb ft)**.
5. Install the engine front cover. Refer to Engine Front Cover Replacement.
6. Install a NEW crankshaft front oil seal. Refer to Crankshaft Front Oil Seal Installation.
7. Install the crankshaft balancer. Refer to Crankshaft Balancer Installation.
8. Install the valve lifters. Refer to Valve Lifter Replacement.
9. Install the right side and left side cylinder heads. Refer to Cylinder Head Installation - Left Side and Cylinder Head Installation - Right Side.
10. Install the valve rocker arms and push rods. Refer to Valve Rocker Arm and Push Rod Replacement.
11. Install the right and left valve rocker arm covers. Refer to Valve Rocker Arm Cover Replacement - Left Side and Valve Rocker Arm Cover Replacement - Right Side.
12. Install the coolant air bleed pipe. Refer to Coolant Air Bleed Pipe Assembly Replacement.
13. Install the intake manifold. Refer to Intake Manifold Installation.
14. Install the water pump. Refer to Water Pump Installation.
15. Install the left and right exhaust manifolds. Refer to Exhaust Manifold Replacement - Left Side and Exhaust Manifold Replacement - Right Side.
16. Install the oil level indicator tube. Refer to Oil Level Indicator and Tube Installation.
17. Install the engine assembly. Refer to Engine Replacement.

Engine Flywheel Replacement

Removal Procedure

1. Remove the automatic transmission. Refer to Transmission Replacement .
2. Remove the engine flywheel. Refer to Engine Flywheel Removal .

Installation Procedure

1. Install the engine flywheel. Refer to Engine Flywheel Installation .
2. Install the automatic transmission. Refer to Transmission Replacement .

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Engine Oil and Oil Filter Replacement

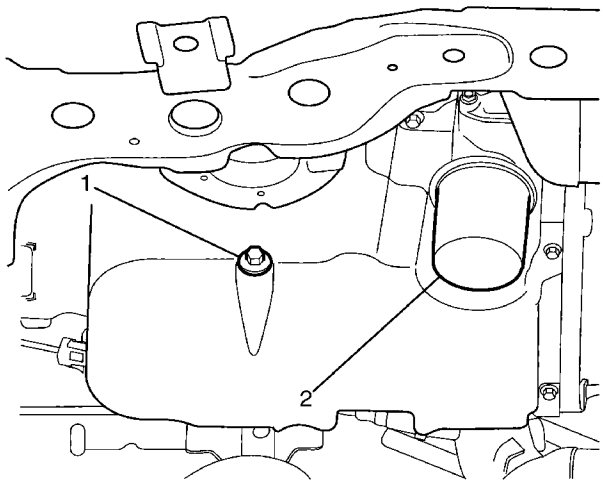
Removal Procedure

1. Remove the oil fill cap.

   Warning: Refer to Safety Glasses Warning in the Preface section.

   Danger: To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

2. Raise the vehicle. Refer to Lifting and Jacking the Vehicle.



3. Remove the oil pan drain plug (1).
4. Drain the engine oil into an appropriate container.
5. Remove the engine oil filter (2).

Installation Procedure

Caution: Refer to Fastener Caution in the Preface section.

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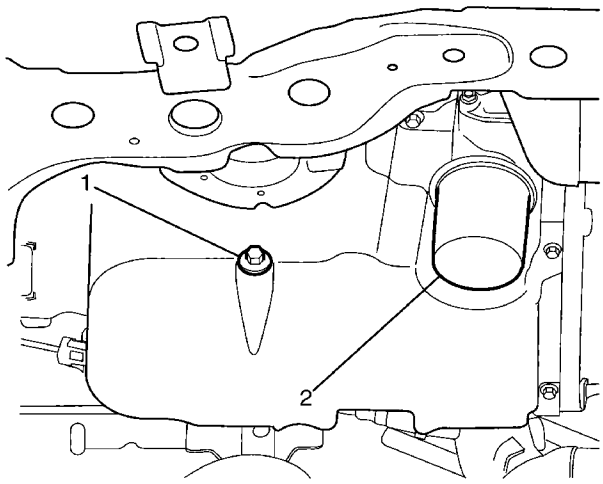
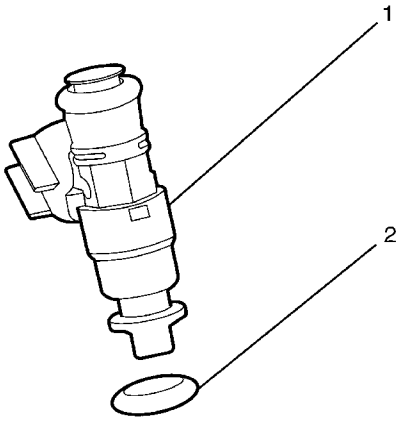


Note: Before installing the new oil filter, ensure that the old oil filter gasket has been removed. If not, remove the old gasket.

1. Install the oil filter (2) and tighten to **30 N·m (22 lb ft)**.
2. Install the oil pan drain plug (1) and tighten to **25 N·m (18 lb ft)**.
3. Lower the vehicle.
4. Fill the engine with a suitable amount and type of engine oil. Refer to Approximate Fluid Capacities and Fluid and Lubricant Recommendations.
5. Check the oil level.
6. Install the oil fill cap.
7. Reset the service reminder display. Refer to Service Display Reminders.

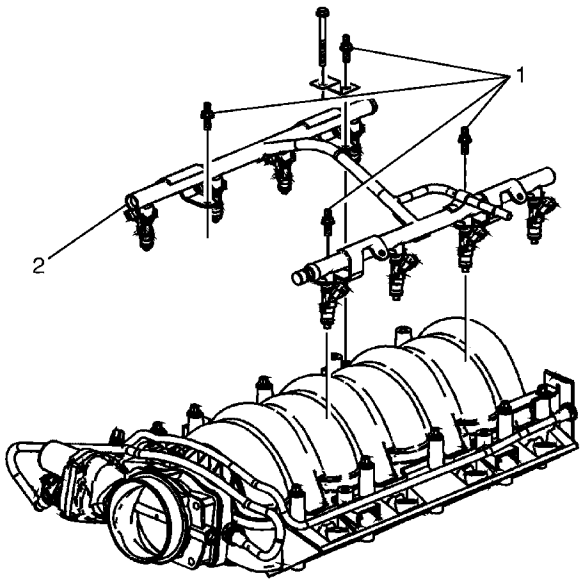
Fuel Rail and Injectors Installation

Warning: Refer to Fuel Rail Stop Bracket Installation Warning in the Preface section.



Note: DO NOT use the fuel injector O-ring seals again. Install NEW fuel injector O-ring seals during assembly.

1. Lubricate the NEW fuel injector O-ring seals with clean engine oil.
2. Install the O-ring seals to the fuel injectors.



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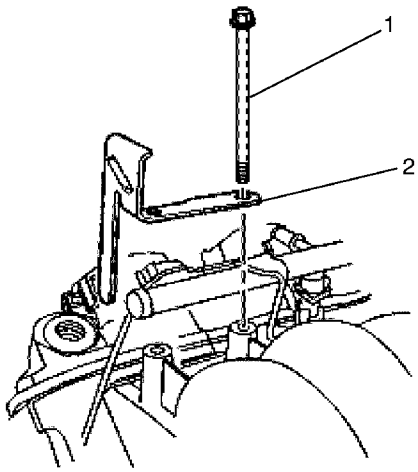
3. Install the fuel rail (3) to the manifold. Push firmly on both sides of the rail until all injectors have entered their bores.
4. Apply a 5 mm (0.2 in) band of threadlock to the threads of the fuel rail bolts (2). Refer to Adhesives, Fluids, Lubricants, and Sealers.

Caution: Refer to Fastener Caution in the Preface section.

5. Install the fuel rail bolts (2) and fuel rail ground strap (1) and tighten to **10 N·m (89 lb in)**.



Note: The fuel rail stop bracket (2) must be installed. The fuel rail stop bracket (2) serves as a protective shield in the event of a vehicle frontal collision.

6. Install the fuel rail stop bracket (2).
7. Install the fuel rail stop bracket to intake manifold retaining bolt (1) and tighten to **10 N·m (89 lb in)**.